electronics

radio, sound, communications and industrial applications of electron tubes ✦ ✦ ✦ design, engineering, manufacture

Looking ahead into 1933

✦

Beauty—to sell more radios

✦

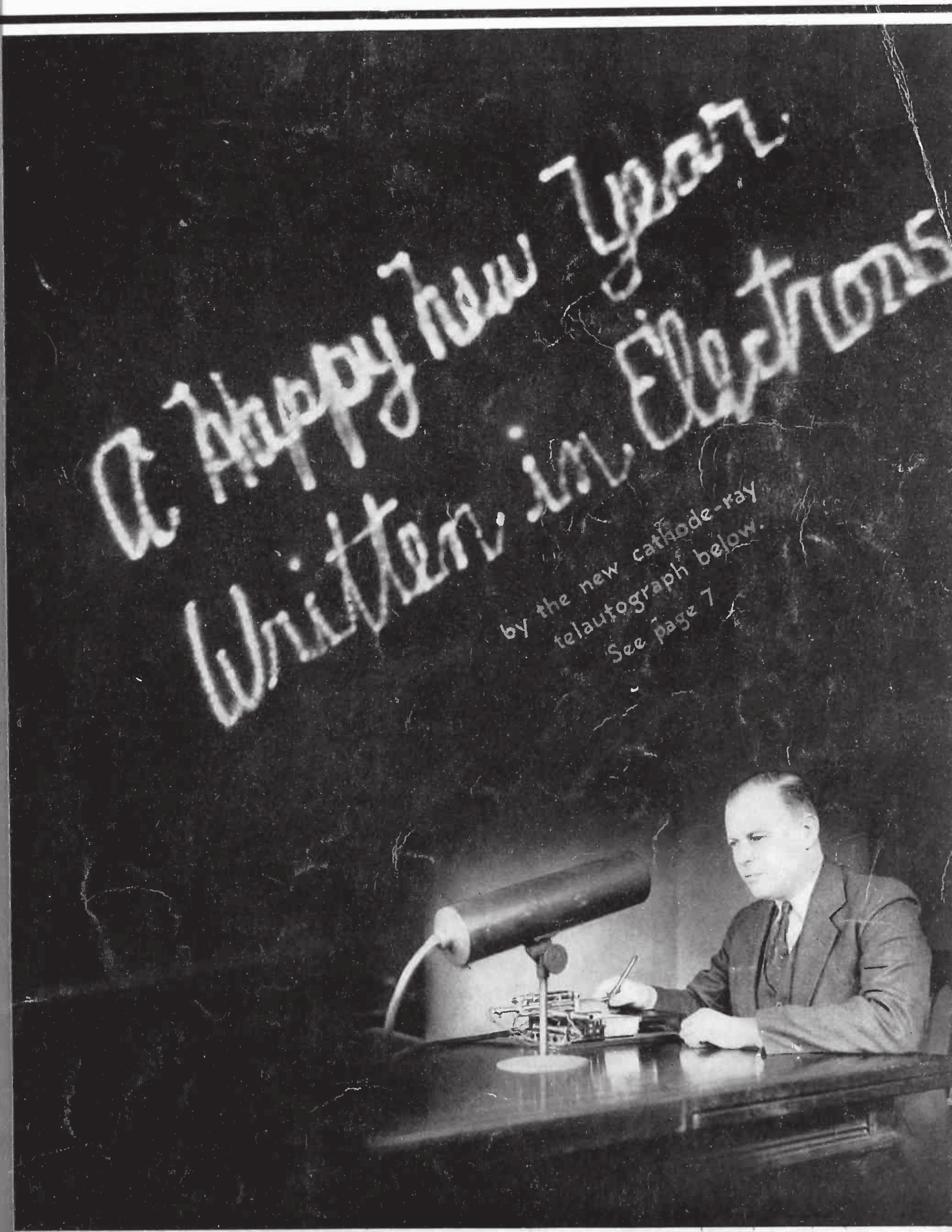
Control of sound-picture quality

✦

Auto-radio progress

✦

New circuits for automatic volume control



by the new cathode-ray telautograph below. See page 7

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Price 35 Cents

JANUARY 1933

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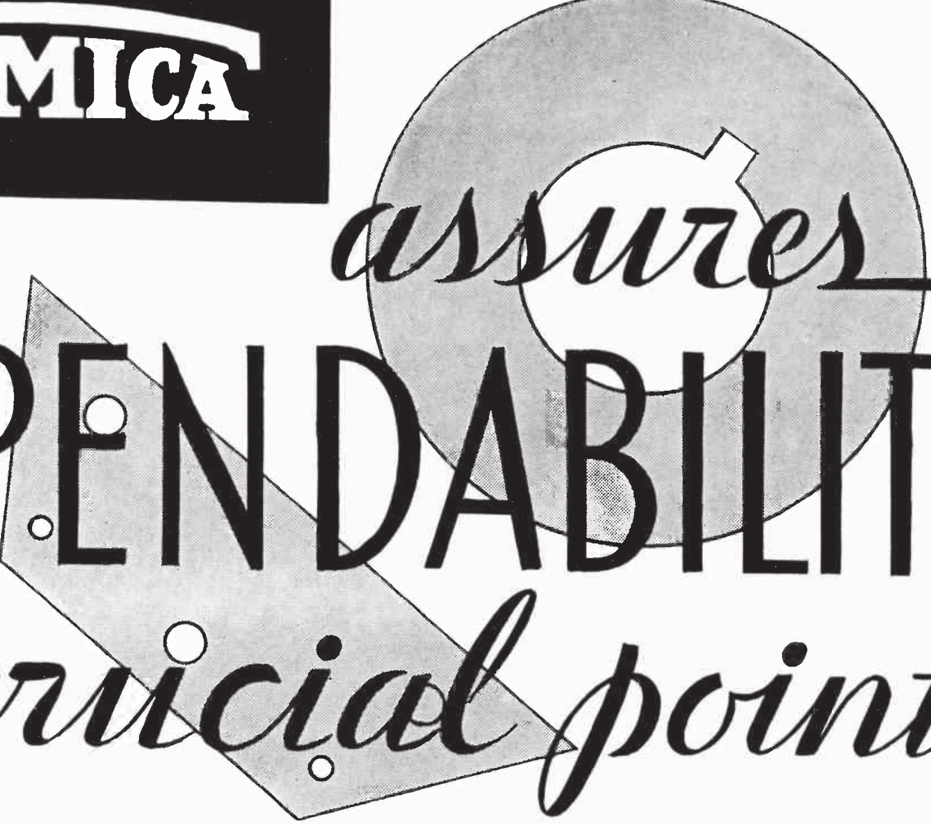

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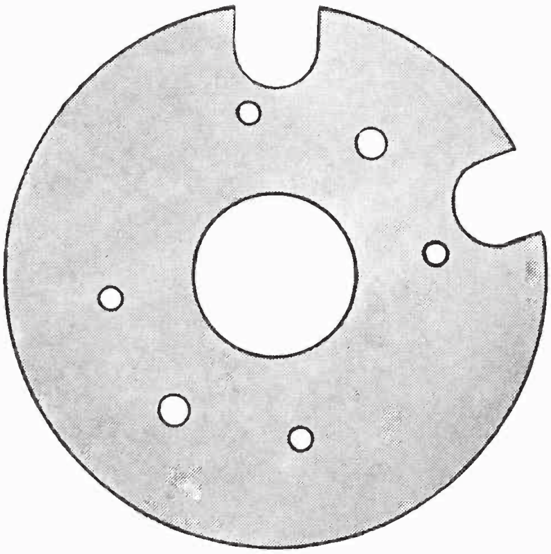

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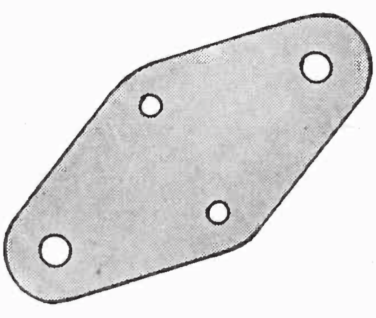

Electronics, January, 1933. Vol. 6. No. 1. Published monthly. McGraw-Hill Publishing Company, Inc., 330 West 42d Street, New York, N. Y. $3.00 per year. 35 cents a copy. Foreign Postage, $4 U. S. Currency or 20 shillings. Canada (including Canadian duty), $3.50. Entered as second-class matter April 4, 1930, at the Post Office at New York, N. Y., under the Act of March 3, 1879.

electronics

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Editor
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McGRAW-HILL PUBLISHING COMPANY, INC.

New York, January, 1933

radio
sound pictures
telephony
broadcasting
telegraphy
counting
grading
carrier systems
beam transmission
photo cells
facsimile
electric recording
amplifiers
phonographs
measurements
receivers
therapeutics
traffic control
musical instruments
machine control
television
metering
analysis
aviation
metallurgy
beacons
compasses
automatic processing
crime detection
geophysics

BEAUTY—

to sell more radio sets?

As THE number of radio receivers in use approaches the "saturation" point, new factors of design must be introduced to restore greater appeal to the buying tastes of the public.

But so far, external beauty of color and form — controlling elements of sales in so many other lines of merchandise—have been almost overlooked in radio receivers. Consoles as a class have little charm or originality. And the infamous "tombstone" model, adopted for midgets, has been a precedent from which only a hardy few have dared break away.

▼

BEAUTY and style are two sales-creating elements which must be injected into radio sets in 1933.

Beauty creates fresh enthusiasm for any product,—provides a new basis for comparison, in place of price.

Beauty opens up new markets,—postpones the saturation point.

Beauty creates obsolescence. And it converts old customers into new ones.

Beauty is one of the least costly elements that can go into the design of a radio set. In fact, a beautiful design may be even less expensive to build than the old crude model.

But beauty is a powerful sales compellant. Its force was exemplified in the recent redesign of a table model "weather-guide." Artistically refashioned, actually twice as many weather-guides were sold during 1931, as were moved even in the golden year of 1929, when only the "engineer model" was available.

Beauty of external form, smart design, charm of appeal to women as well as men, are the intangibles which can help build back radio volume in 1933.

But such artistic design to be effective, must be the work of experts in good taste. The requisites needed are not likely to be found around the engineering drafting room, or in the painful Victorianisms of the average furniture plant.

▼

THIS year 1933 is a time for fresh ideas of design. This is the day when creative artistry must be given the same sway in shaping the external form of the radio set, as the engineer has enjoyed in perfecting its "innards."

As a stimulant to sales, beauty will prove the best 1933 investment for the hard-boiled business man intent on selling more radio receivers.

LOOKING AHEAD

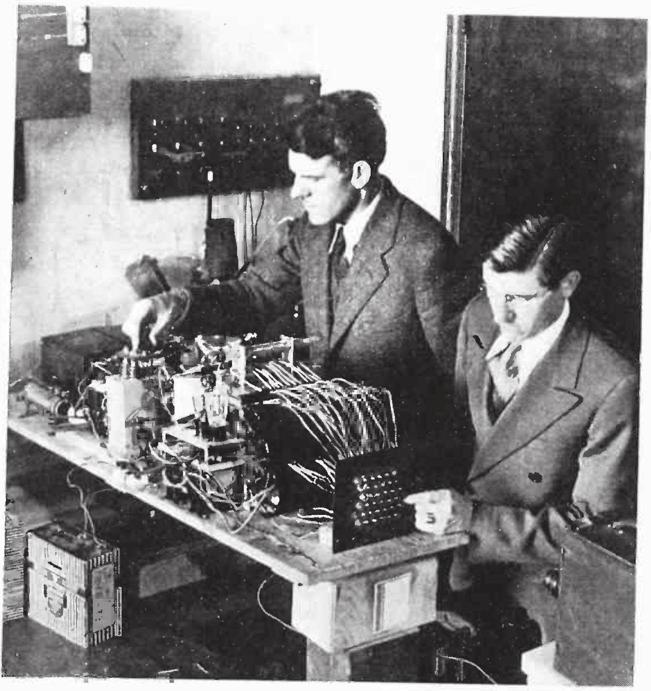
THE year 1933 is a year of new horizons in electronics. Steadily, persistently, the usefulness and variety of electronic-tube applications widen out. Meanwhile, the installations of a few years or months ago rapidly shake themselves down into regular, dependable operating routine.

It is in the ultra short waves and in television that romance still abounds; the impossible today may always be the possible tomorrow. The photocell and all its works have largely simmered down into mechanical ingenuities of use and application, while the roster of different uses endlessly expands. And the electronic tube in power and control applications, constantly finds new fields to conquer as great power currents and motor equipments rush to do the bidding of their tiny electronic commanders.

New aids to television

As 1933 opens, television is temporarily outside the center of public attention; yet perverse child that she is, television today gives more promise of performance than at any time since her theoretical discovery by Nipkow in 1888.

Development of the cathode-ray tube goes on, and several extremely satisfactory images are now regularly produced. The wizards at Camden continue to refine the equipment used with the Empire State Tower job, but have essayed no further public demonstration. At Philadelphia, Farnsworth is working on electronic scanning for Philco. At Purdue, in Indiana, George has developed excellent detail of cathode-ray-tube reception in co-operation with Grigsby-Grunow.



By means of neon lamps, this "hodoscope" invented by Dr. T. H. Johnson of Franklin Institute, traces direction of incoming cosmic rays. It was exhibited at Atlantic City A.A.A.S. convention

In the scanning-disk receiver field, Garner of Western Television is producing a receiver to sell at $75, and is offering this in Kansas City in connection with a studio service which KMBC, the Columbia outlet in Kansas City, is putting on locally. This picture is of a special character, with successive scanning of numbered alternate lines, which does not lend itself to being picked up by other standard receivers.

Meanwhile a brand-new element is injected into television in the use of Rochelle-salt crystals to modulate the light-beam, by their inherent rapid mechanical flexure, demonstrating that mechanical methods are not yet exhausted. Myers' new mercury-vapor light source, with its high luminous efficiency and ability to respond to high frequencies, has brought in still another factor for the use of future television designers.

During the year just closed considerable progress was made in exploring the ultra-high frequencies. Notable work was done by members of the Bell Telephone Laboratories, the RCA Victor Company and RCA Communications, Inc. and the Westinghouse engineers. After experiments on waves below ten meters transmitted from Camden and later from the RCA Building in New York City, two antennas were erected on top the Empire State Building. These antennas are the highest structures above ground level ever erected by man. The bases of the vertical half-wave 6.8 and 4.9 meter antennas were roughly 1,280 feet above ground. The 6.8 meter transmitter (44 Mc.) had a power of 2 kilowatts and was used for picture transmission, 120 lines. The sound transmitter of 1 kw. used the 4.9 meter (61 Mc.) antenna.

Observations made by airplane, automobile, auto-gyro and dirigible indicate that field strengths of the order of 5.5 and 3.0 millivolts per meter would be found at a distance of 4 miles from the 44 and 61Mc. transmitters respectively. At 8 miles the field strengths were 2.3 and 1.5 mv/m; at 20 miles they were 0.7 and 0.4 mv/m and at 40 miles 0.2 and 0.09 mv/m for the 44 and 61 Mc. transmitters.

Signals were heard as far away at Mt. Washington, in New Hampshire, 284 miles, and 37,600 feet below the line of sight from the top of the Empire State Building, at Montauk Point 130 miles and at Albany. At 100 miles the signals on the ground were about equal to the 284 mile signal obtained at an elevation of 6,290 feet. These signals were audible, but not much more.

Assuming a desired minimum signal of 1 millivolt for a 120-line picture, the range of the 2-kw. 44 Mc. transmitter was about 15 miles. On 8 meters a 10 kw. transmitter, 1,200 feet above the ground would deliver a one-half millivolt signal at a distance of 27 miles; on 3 meters the distance for a same signal would be reduced to 22 miles.

Interference on such waves was chiefly due to automobiles. Other sources of noise were telephone exchanges, airplanes in flight, and electric trains. It was found that a six-car elevated train would not cause as much trouble as a single automobile of a given make. Some automobiles could be heard for several blocks and all cars made some noise.

It was estimated that transmitters of 2 kw. as high as

AS 1933 OPENS

the Empire State Building should not be placed closer together than 100 miles provided high quality sound or picture transmission is desired.

According to L. F. Jones of RCA Victor who delivered one of three papers before the New York section of the I.R.E. on the subject in November, "no inexplicable phenomenon of immediate importance has yet been encountered. It is assured that for transmission of television broadcasting, sound broadcasting, facsimile broadcasting, aircraft communication, police communication, and other types of public and private communication, ultra-short waves will prove definitely useful."

Applications of photo-sensitive cells

In the industrial and commercial field, the expanding use of photocells has surprised even the enthusiasts. New applications are appearing from day to day, and a new degree of dependability is being felt for photosensitive devices. Important services in navigation, aviation, traffic control, elevator travel and safety protection, now employ photocells with full confidence. Meanwhile such installations as restaurant "magic doors" and elevator safety-rays, are demonstrating that they can be operated at actual money-saving compared with the expense of getting along without them. Thus a metropolitan restaurant saves enough dish-breakage to offset the carrying cost of the installation, while the speeding up of service, amounts to the equivalent of $2,500 worth of rental space otherwise needed to do the same volume of business. Elevator-door protection with photocells can be financed out of the saving in accident insurance premiums. Some 58 of these light-protected elevators are now being installed in Radio City.

Photocell applications may be expected to increase in variety and in ingenuity as new uses are found for this ubiquitous device. Expansion of the number of installations of each type of use will probably wait on the coming of better times, but progressive concerns and individuals are already showing leadership in adopting photoelectric control, counting, measuring, and color analysis.

Power uses of tubes

During 1932 there was installed a rectifier utilizing electron tubes taking alternating current from a 13,800-volt distribution system and supplying 250-volt direct current to an Edison three-wire system. This equipment is installed on the lines of the Edison Electric Illuminating Company of Boston. Previously the rectifier apparatus was given service tests carrying the load of the Schenectady trolley lines.

A new type of metal-envelope tube has been commercially developed. This hot-cathode mercury-vapor rectifier tube consists of an indirectly-heated cathode surrounded by a metallic shell which acts as the anode and as the enclosing envelope. Each of these new metal tubes is capable of rectifying 100 amp. average current at the usual commercial voltages and frequencies.

The year 1933 will see the introduction of many more types of tubes designed for radio receivers. The first of the new brood will appear early in January and undoubtedly the birth-rate will continue high throughout the year, as the result of continued research and development on the part of both set and tube engineers. Such tubes will bring to play a new order of complexity, of usefulness, or power output or amplification and serviceability. Most of them will bear numbers according to the new system of nomenclature.

Short-wave police systems increased rapidly in 1932. Now photocells detect speeders. And here's the latest, a microphone feeding loudspeakers a quarter mile away, so the policeman can instruct drivers as far as he can see them

One of the first to appear is the 25-Z-5 rectifier aimed directly at the a.c.-d.c. receivers now attracting so much sales attention. By the middle of January some fifteen other types will be announced.

Receiving sets

It is certain that renewed engineering effort will be made to bring the more expensive technical features into the cheaper sets, and to find new services for the high-class sets. A concerted effect is to be directed toward bettering the broadcast system not only from the receiver standpoint but from the transmitter as well. To that end new loud speakers, new low levels of distortion, new high levels of power output, new possibilities of control will find their way into radio sets. New microphones, new lines, new schemes of avoiding modulation distortion will be found in the better broadcast stations as the year goes on.

Already evident is a trend toward the inclusion of an heretofore alien note in broadcast furniture, the note of beauty. To date radio sets have worked well and have cost little—in the future they must look well too. This development will come during the present year.

The place of NICKEL in radio tube manufacture

By A. J. MARINO
Gilby Wire Company

Machinery in use in a nickel rolling mill

THE importance of nickel to the radio tube industry is well known. Hundreds of tons of the metal are used annually for making the plates, grids and supports that go into the fifty-odd millions of tubes used for radio receivers and for the thousands of larger tubes. There are good practical reasons why this element has become so widely used; they will be outlined below. Before listing the technical characteristics of nickel it may be worth while to state why it is the standard metal for radio tubes. They are:

1. It can be obtained in high purity at a reasonable cost.
2. Being a pure metal, it has uniform quality, and physical properties that can be controlled and duplicated without trouble.
3. Nickel does not tarnish in air, and is not corroded by handling, nor from changing atmospheric conditions.
4. It is soft and easily workable. In sheet, it can be formed into almost any shape. In wire it is easily cut, bent, and wound. Sheet can be carbonized and still remain soft enough to be shaped in automatic machines. The wire in fine sizes is readily woven into mesh which can be cut into shape for all purposes. The metal is easily spot welded and makes easy the fabrication of the tubes.
5. The melting point is high. It can be fired at high temperatures, and is readily cleaned in hydrogen gas.
6. A very important feature in the use of nickel is that the scrap commands a high price. There is always a good market for its sale.
7. Nickel forms alloys with various metals which are very important in special applications in the tube industry.

The commercial grade of pure nickel, which in the trade is called "grade A," is used in sheet form for punching and forming plates, in wire for supports, and in finer sizes for grid winding and for the manufacture of mesh for screens.

The specific gravity of nickel averages 8.84, according to the amount of mechanical working to which the metal has been subjected in the manufacturing processes. Its melting point, as given by the Bureau of Standards, is 1452° C. (2636° F.). On page 5 are its chemical and physical characteristics which make it and its alloys so useful in the manufacture of high quality tubes at minimum expense by reducing final inspection rejection losses.

Nickel in grid manufacture

Nickel has always played a part in the manufacture of grid wire, but is now taking a more prominent position by the use of its alloys in replacing more expensive materials. This has been accomplished after a considerable amount of research and development. It was necessary to duplicate in the nickel alloy certain physical properties previously obtainable only in the more expensive metals. Other studies were made to meet variable conditions found in grid-winding machines.

The manufacture of the alloys to meet conditions found in the various shapes for grids, such as round and flat types, meant, besides the composition of the metal, the control of tensile strength and elongation of the wire. Alloys which successfully have met requirements of grid manufacture are as follows:

1. Manganese nickel
   (2 per cent and 5 per cent manganese)
2. Nickel 60 per cent chromium 15 per cent
3. Nickel 80 per cent chromium 20 per cent

To obtain the full value of these alloys, care is taken in the manufacture of the wire to keep the sizes accurate within limits of 0.0001 in., truly round in shape, and uniform in physical characteristics.

Pure nickel in sheet form is used for the manufacture of plates, cups, discs, and smaller parts. The thicknesses in use range from 0.0015 in. to 0.010 in.; the widths range from 0.025 in. to 2 in. In the manufacture of the radio sheet from metal billets extreme care is taken throughout the operation to insure the attainment of proper metal structure and quality to meet the high standards necessary for the radio trade. The manufacture of this sheet requires scientific control with the best knowledge of metal practice. Machinery of high precision together with special methods of handling nickel have been developed so that at no time in the manufacture are the natural properties of the metal affected. The finished sheet is annealed in special furnaces using an atmosphere of hydrogen gas, and with temperature control and constant speeds, tempers are kept uniform.

Nickel sheet, to meet the requirements of tubes in which the plate current is high, is carbonized to increase heat radiation. The manufacture of carbonized nickel consists in chemically applying to the surface a coating of pure carbon in apparatus especially constructed to keep it uniform in quality and in thickness, it is possible to produce carbonized nickel soft enough to retain its shape after being formed in automatic machines.

Nickel for support wires

Nickel wire is used in the radio tube for supporting the various parts. It is most important that the material for this purpose be kept uniform in size and of even temper so that it can be easily formed in automatic machines. All nickel wire is annealed and cleaned in electric furnaces with hydrogen gas to eliminate foreign matter.

When a more rigid wire is necessary, an alloy of manganese nickel is used for support wire. A special soft wire is manufactured for grid supports to allow the cutting and swaging operations to be easily performed without extreme wear on the tools. This is specified in the trade as "double annealed."

In the weaving of mesh for radio screens, fine sizes of nickel wire are used, the most popular being 0.007 inch. This mesh is principally woven 60 by 60 and 60 by 40. It is possible to obtain this mesh with special edges to prevent loosening of side wires in the subsequent manufacturing processes. Carbonized mesh can be manufactured, and is used for special purposes.

Pure nickel is used as a base for coated filaments because its chemical properties make possible, by a surface reaction with the barium salts of the coating, the formation of an activated film which emits a large supply of electrons. For high filament efficiency, it is necessary to use a nickel of extremely high purity in which are eliminated certain small impurities that, because of their effect on this film, result in "low emission" and short life of the tubes.

ANALYSIS "GRADE A" NICKEL

Nickel	99.00 per cent (plus)
Iron	.50
Manganese	.30
Copper (maximum)	.18
Silicon	.20
Carbon	.10

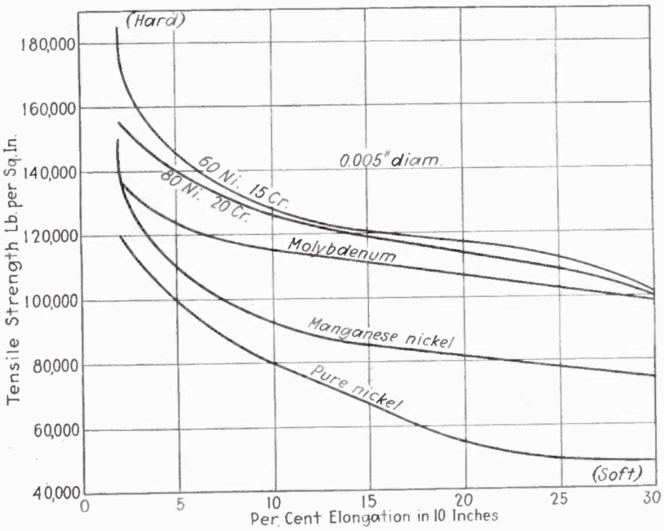
TENSILE PROPERTIES—LBS. PER SQ.IN.

Sheet	Hard rolled	90,000	110,000
	Soft annealed	60,000	75,000
Wire	Hard drawn	90,000	110,000
	Soft annealed	65,000	75,000

It is highly important to control the purity of filament nickel. To that end small melts are made so that extreme uniformity throughout the metal billet is attained. Each melt is carefully analyzed so that there is absolutely no trace of harmful elements present. Each batch of material is given a melt number and this number is supplied to the user with the nickel. This is very important as it allows a constant check by the tube manufacturer on his own processes and provides a record for checking filament performance. All of this procedure is expensive, but worthwhile since it results in higher quality radio tubes.

Nickel filament is principally used in ribbon shape. Extreme care is taken in the rolling of the material so that there is no variation in size. For certain types of tubes it is necessary to keep the tolerances on physical dimensions as close as 0.00005 inch. The rolling of filament is an operation of extreme importance, and requires the use of high precision equipment. Sizes are checked by microscopic projection using magnifications of 1,000 diameters.

The highly important feature of uniform size, together with weight per standard length, cannot be stressed too emphatically. Besides chemical purity and physical dimensions with weights adjusted, important points in filament control are the electrical resistance and temperature coefficient, which must be kept within close limits. This is important because nickel has a very high temperature coefficient, and if not kept uniform will give large variation in the filament when heated. The exact control of slight amounts of certain impurities is very important as it has a great effect on the electrical properties. The largest factor in the cost of radio tube filament manufacture consists of labor and scientific control. The resulting high quality has always proved to be cheaper in the final tube cost.



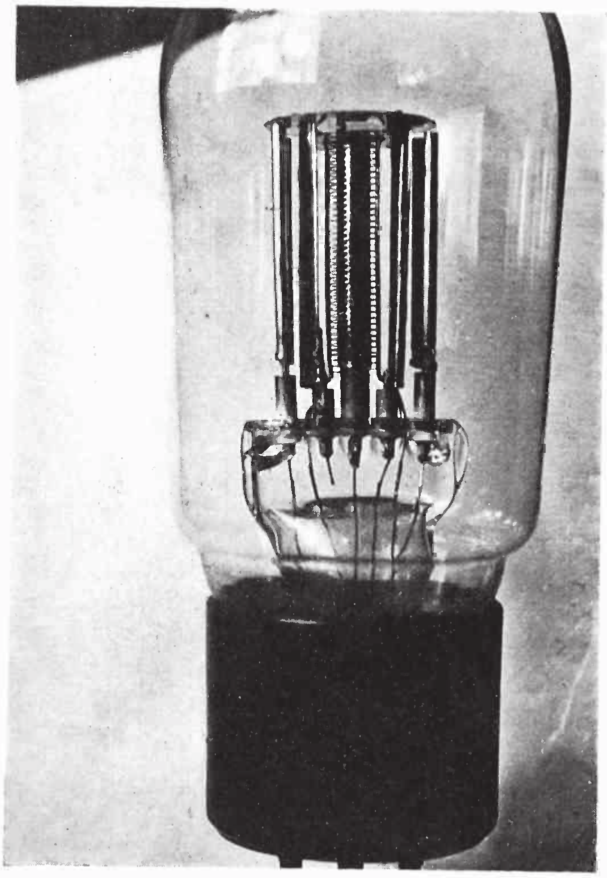
Physical data on various metals used for grid windings

An important feature of filament manufacture is the control of hardness. For this, the percentage of elongation has been made a standard for the specification of the material. It is necessary that the finished filament be cleaned very thoroughly to remove from its surface any impurities which would be injurious to the coating, and in the functioning of the tube. For special applications, filaments are made of nickel alloys, such as silicon nickel, nickel cobalt, etc.

Tubes with cold cathodes

Dr. August Hund describes work before the I.R.E.

IN A paper presented before the Institute of Radio Engineers January 4, Dr. August Hund of the research staff of Wired Radio, Inc., described the results of his work on glow-discharge amplifiers, oscillators, and modulators. Although privately demonstrated at various times during the past year and first publicly announced in *Electronics* (September and November, 1931) this was the first public explanation of the principles involved and the first public demonstration of apparatus built around the filamentless tube.



The above tube is a sample of gas-discharge tubes made by Dr. George Seibt of Germany, a pioneer in the development of tubes without filaments. According to Dr. Henry J. Miller, through whose courtesy this photograph is presented, this tube has discharge cathode and anodes of iron, control grid of molybdenum, uses either neon or helium at various pressures from 3 to 6 mm of mercury. The discharge potential is 80 to 250 volts; the plate potential 20 to 30 volts; power consumption in the glow discharge is from 4 to 7 watts

Two types of tube have been developed, one depending upon the conduction of negative ions and the other operating on the negative resistance principle similar to the Poulsen arc. In both cases the source of electrons is a glow discharge which takes the place of the familiar thermionic cathode. In general such tubes, depending upon the ionization of a gas, have a characteristic with three distinct regions. Plotting anode current against voltage, at first the increase in current is very slow and quite uniform. The total current obtainable in this region is very small. Dr. Hund calls this region the "Seibt region" for the reason that Dr. Seibt in Germany seems to have concentrated his efforts on making a useful amplifier out of this portion of the characteristic.

At the end of this region is a very abrupt increase in current with any small increase in plate or anode voltage and at the end of this up-shooting curve is a much less steep increase in current giving a characteristic resembling that of a thermionic tube. According to Dr. Hund, tubes have been made in which the first two regions have been eliminated, giving a plate characteristic very similar to that of more conventional tubes.

The construction of the tubes was illustrated; the effects of varying the nature and pressure of the gas were explained, and curves were given showing the characteristics of tubes having plate resistances of 7,000 ohms, mutual conductances of 3,000 micromhos and input impedances of the order of one-third megohm.

With respect to the life of the tubes, the speaker explained that he had noted no gas clean-up. With respect to the uniformity with which the tubes could be manufactured in quantity Dr. Hund said that they were not critical as to construction or pumping. Air at 8 mm. pressure seemed to have about the same characteristics as helium at 40 mm.; the heat to be dissipated does not differ appreciable from thermionic tubes; the efficiency is about equivalent. In a typical tube about 6 watts were required for the glow discharge.

The simple construction of the elements and the possibility of using cheap gases added to the absence of necessity for careful and long exhaust, gave evidence of the fact that the manufacture of this type of tube would not be expensive.

The use of both types of tubes as oscillators in connection with piezo-electric crystals was described. An interesting method of generating three phase oscillations by means of the negative resistance form of tube operating on the relaxation principle, in conjunction with a piezo-electric rod was described. In this system a standing wave was created on the rod and two voltages with the proper phase difference between them are taken off the rod by means of amplifiers.

The tubes have been operated in their various capacities over the audio and radio frequency ranges extending into the ultra high frequency field. The use of the tubes in multi-channel transmitting and receiving equipment was also described. Relaxation oscillators functioning as low as 50 meters or lower were possible according to Dr. Hund.

Several demonstrations of the tubes in actual circuits

[Please turn to page 22]

The cathautograph

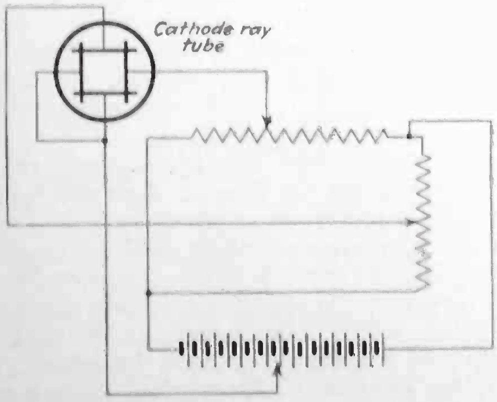
An electronic pencil

By ALLEN B. DUMONT

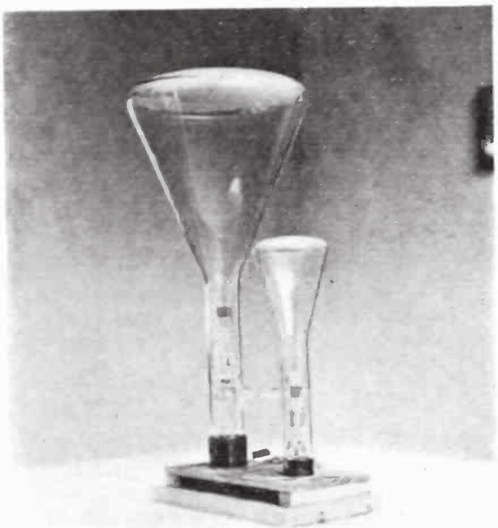
WITH the recent improvements in cathode-ray tubes which enable a high intensity spot of sharp focus to be obtained at relatively low anode potentials, many uses which have previously been impractical suggest themselves. In addition the stability, long life and moderate cost are rapidly placing the cathode-ray tube into industrial applications.

The Cathautograph is an interesting and useful application making use of a cathode-ray tube for the transmission of intelligence either in printed or written form. The electron beam is controlled by a suitable transmitting apparatus which causes the spot to move in any desired direction for any desired distance on the screen. If a standard cathode-ray tube is used for this purpose the operation of the transmitting apparatus would cause the spot to move around but it would be impossible to tell what was being printed or written. However special salts have been developed which instead of having a decay period of a fractional part of a second as is the case with the commonly used Willimite or calcium tungstate, have a decay period in the neighborhood of thirty seconds. This lag causes a line to be drawn as the spot moves. At present some ten words can be seen on the fluorescent screen of the cathode-ray tube at one time. As the eleventh word is being written the first word has faded out.

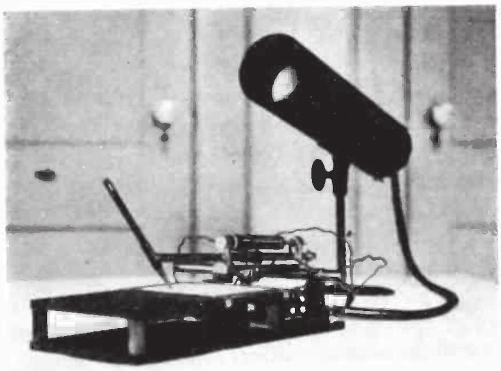
The transmitting system consists of a pencil or stylus which is connected with two resistances so that as the pencil is moved a voltage is picked off the resistances which is proportional to the movement of the pencil. The receiver consists of a standard cathode-ray tube with two pairs of deflection plates. In the photograph is shown the largest and smallest standard commercial size. The small three-inch screen tube was used to write the season's greetings on the cover of this issue of *Electronics*. The large tube has a nine-inch diameter screen and of course much larger writing can be obtained with it. A suitable shielded stand or holder supports the tube. The voltage picked off one resistance is applied across one pair of plates and the voltage picked off the other resistance is applied across the second pair of deflection plates.



Circuit used in the "electronic pencil".



Standard 3 and 9 inch cathode ray tubes



Cathautograph operating from a. c. The power supply apparatus is not shown

Provision has been made so that when the pencil of the transmitter is brought into writing position the receiver at the distant station is set into operation which requires less than two seconds. A buzzer signal is also operated at the distant station. Provision has been made so that when the pencil is lifted from the paper the spot is turned off eliminating traces between words.

The Cathautograph may also be operated over radio circuits by modulating two separate tones on a single carrier. At the receiver each tone is rectified and used to operate a set of deflection plates.

Some of the applications which suggest themselves are communication between airplanes and ground stations, communication between small vessels at sea not carrying a licensed operator and land stations, office intercommunication and communication between distant offices, communication between police department and radio equipped squad cars, noiseless instructions to broadcast artists, Chinese or Japanese communication circuits and also for advertising purposes.

Auto-radio an expanding market in 1933

Police radio increases

A QUARTER of a million automobile radios will be sold during 1933 according to estimates made by prominent radio and automotive manufacturers. This optimistic figure is based on the growth of sales figures during 1932 and is colored somewhat by the high degree of public interest shown late in the year. The average price of these sets will be in the neighborhood of $45 if sold without power supply or approximately ten dollars more for complete a.c. operation.

A survey of all automotive manufacturers to determine the extent of their interest in radio disclosed little change in sentiment from a year ago. Most of them will install radios if the customer demands it; to date none has decided to take the bull by the horns and put a radio into every car; about half of the cars have antennas in them when they leave the factory; many of the radio sets will no longer bear the trade mark of the radio manufacturer but will be much more closely identified with the automobile.

General Motors cars, and those of Dodge and Ford will have provision for radio so that installation will be simple. Furthermore, special radios are engineered for these cars bearing the name of the automobile, thereby removing from the customer's mind knowledge of the part the radio designer, the engineer or the manufacturer played in the construction of the unit. Radio therefore becomes to the automobile manufacturer and the ultimate owner merely an accessory, a gadget; the car is the important thing.

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Rapid awakening of public interest; cooperative efforts among radio and automotive engineers, and reduction in prices will make the market for receivers to be installed in pleasure cars expand to a considerable extent in 1933.

The industry hopes for a car manufacturer to make auto-radio as an integral part of his entire output of cars. The automobile industry, still considers radio as a gadget to be installed if the car owner wants it.

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At present the automobile manufacturer and dealer is more than mildly interested in radio because of the necessity to boost the dollar volume of sales. In better times when many thousands of cars must be replaced with new ones, an auto dealer or maker's interest in radio will wane again, and again the car will become of primary importance.

At present there is no automotive manufacturer who has decided to equip every car with a radio as it now journeys from the factory, as it does with an extra wheel. This status may change over night; once started such a bulge might assume large proportions. Such a demand would be filled by the radio manufacturer selling his entire output to some auto maker, and might easily account for appreciable profit. The tie-ups between Ford and Majestic, between U. S. Radio and Television and Chevrolet are interesting and important trends, pointing to the loss of identity of the radio partner in the auto-radio combination.

It is generally felt that it will be impossible to sell sets to cars over two years old. The table below shows a very large market even under these restrictions.

New cars sold

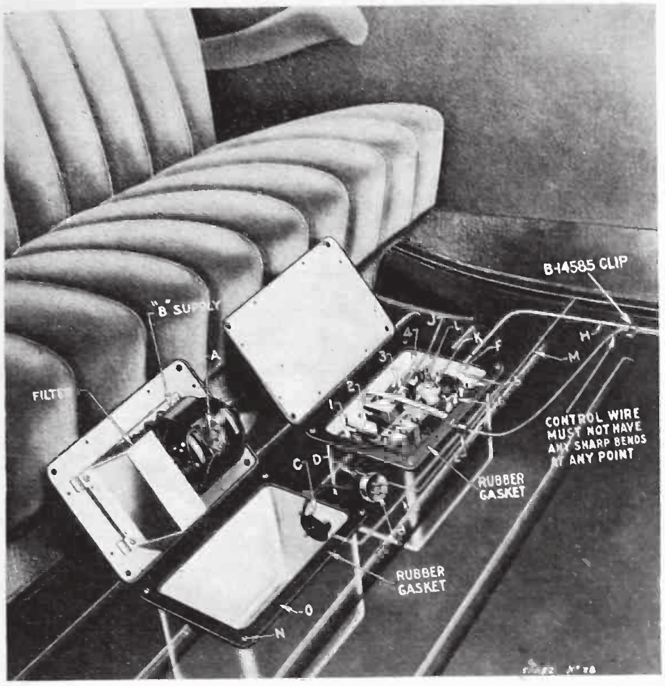
1930	2,625,979
1931	1,908,141
1932	1,125,000
Total	5,659,120

There is also a feeling that the more expensive cars will be easier to sell; but on this point there is much argument. Some feel that the owner of an expensive car has problems on his mind too weighty to be relieved by radio tunes or talks.

Who will sell and install?

There are three possible types of outlets for receivers to be installed in automobiles. The radio dealer, the auto dealer, and finally a newcomer, the auto-radio specialist. Of the latter there are perhaps 2,000 operating at the present time. They seem to have the best qualifications for capitalizing on this admittedly large market. The radio dealer knows most about radio but has an inferiority complex when it comes to tearing the top out of a car for the purpose of installing an antenna or of drilling holes in dash or floor boards. The automobile dealer has the necessary tools and experience to do practically anything to the automobile but lacks confidence to tackle ignition noises and other anticipated and feared radio troubles.

The problem of credit enters the picture too. The automobile dealer has the edge on the radio man here; in addition he has a place in which to work. But the radio dealer who seizes all opportunities may capitalize on the fact that auto radios can be installed in the car owner's garage. The specialist, doing nothing but installing radio receivers in automobiles, can combine the knowledge and experience of both the other types of dealer and because this is his primary job can work it harder, taking advantage of all kinds of sales efforts and



The Ford-Majestic manual of instruction gives complete directions for installation of the radio in the car

the word-of-mouth advertising that is so valuable. One well known radio manufacturer estimated that less than 30 per cent of all auto radios would move through the regular radio channels.

In six New England states one jobber sold 3,000 radio sets for automobile installation during the four months preceding November. Two types of sets were sold, one cheap (about $60) and the other about $15 higher. The ratio of expensive to cheap sets was two to one; 90 per cent of the sets moved through automotive dealers.

The time and cost of installation will come down appreciably in 1933. The present charge of $10 seems to be due for some revision downward. The time of installation will probably level off at between one and two hours, what with the interest automobile engineers are taking in equipping their cars with antennas and in providing places for the radio added to the skill which radio engineers are showing in putting their tubes and components in compact metallic containers simple to install.

Road tests will be instituted to determine the ability of the radio and power supply unit to stand up under average driving conditions. One radio engineer making a quality product installed an experimental model in his car, drove it a thousand miles over winter roads and found to his gratification that the use of lock nuts properly placed had been worth while. A maker of B eliminators of the vibrator type uses as part of his promotion the fact that one of his units had gone through the Indianapolis races effectively surviving 10 million jolts.

A distinct trend toward built-in power supply units whether of the vibrator or rotating machine types was evident toward the end of the year. Opinion was still divided as to whether the older and better known type of machine, the dynamotor or equivalent would prove to be more satisfactory than more elegant methods of getting high voltage from the car battery. It is significant that Ford chose rotating devices for his cars. It is known that other automotive manufacturers look with critical eyes on the problem of getting plate voltage from the car battery. Dodge, for example, has very recently equipped 1,000 Plymouths with radios as demonstrator cars. Many of the bugs of the proposition will undoubtedly be ironed out as a result of such large scale trial installations.

RMA-SAE joint meetings

A very hopeful sign in the auto-radio heaven is the cooperation between members of the leading automotive engineering organization, the Society of Automotive Engineers and the members of the Radio Manufacturers Association. In September members of the two groups met in Detroit and discussed many of the joint problems. Such matters as sources of interference, battery drain, location of receiver in car, antenna installation were discussed and committees were appointed to handle more technical aspects of the items.

At a meeting of the RMA Committee on Automotive Radio in Detroit early in December representatives of all but two of the major radio manufacturers discussed such matters as radiation from the car, life testing of B power devices, interference from dome light wiring, the rating of sensitivity of automobile receivers and other technical problems. In a report of the committee on B power devices, it was recommended that a voltage of 6.3 be chosen as design and test center and that at least 1,000 hours' operation be taken as satisfactory for a B power device. If the unit operated satisfactorily for this period with some small service charge at the half-life period, it would be considered as satisfactory.

Radio receivers for police cars

During 1932 a number of prominent and large municipalities installed police radio systems, adding their names to a long list of the cities and states which have seized upon radio as a deterrant to crime and an aid in the apprehension of criminals. New York City was among these cities, installing two transmitters of Western Electric manufacture and many police cruisers with receivers made by United American Bosch.

Thus the design and manufacture of radio receivers for use in police cars has become an appreciable part of the automobile radio industry. Although the receivers are built to different specifications and different wavebands, the essential problems are the same—without the price chiseling! A police radio receiver must perform at all times and with minimum service; dependability is more important than high fidelity or great sensitivity.

The advent of police radio and the wide-spread sale of short-wave receivers to the lay listeners have brought strange problems. There is nothing difficult about procuring a receiver for receiving the police calls, in fact many manufacturers of sets working in these wave bands advertise the thrill of listening to such communications. Therefore criminals find it to advantage to equip their cars as effectively as the police in some states leading to absurd and unenforceable laws prohibiting the installation in cars of receivers which will tune below 200 meters! Such laws will not deter the production and installation of radio receivers in automobiles either to receive the broadcast-band stations or to go down into the other wave bands where other and withal more interesting and exciting programs are available. Doubtless the market for police radio receivers will continue to provide manufacturers with outlets for high class sets of this special nature.

Control of sound quality in picture production

By CARL DREHER
Director of Sound, RKO Studios, Inc.

THE fidelity of which a sound picture recording-reproducing system is capable depends on its design and is therefore, initially the responsibility of the design engineers. But the problem of *maintaining* the best possible quality is one for the operating engineer or studio technician. If he does not know his job, the equipment may function badly, resulting in sub-standard sound, or it may not function at all, resulting in costly delays in production.

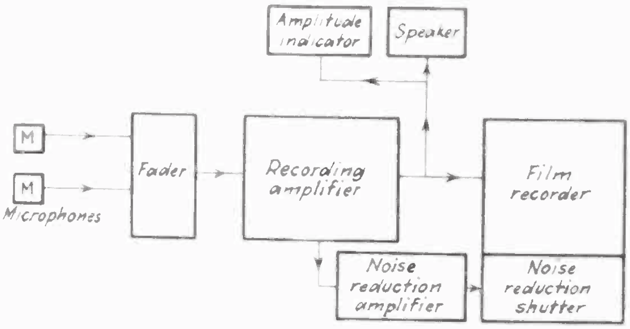


Fig. 1—Block diagram of recording system

Although in sound-picture production the problem of controlling unskilled personnel is not encountered, since the number of workers is low enough to permit employing only qualified men, it is the business of the supervising engineer to organize a maintenance and testing routine which will impress his own presumably greater skill and experience on the personnel all the way down the line. He does this by leaving nothing to chance and overlooking no opportunity to observe and measure the characteristics of the product—in his case, a sound track only 70 or 80 mils wide, but in the aggregate of a year's recording in a major studio, many millions of feet long.

The maintenance and test methods to be described in this article pertain particularly to RCA variable area recording as used at RKO Studios in Hollywood, but the basic principles are the same for any system of recording and any studio.

Fig. 2—Variable area track (print) with noise reduction

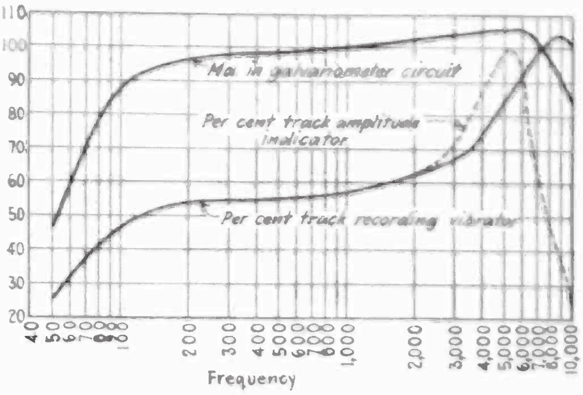


Fig. 3—Recorder frequency characteristics

Figure 1 is a block diagram of the principal elements in a film recording system. Beginning with the microphone, we will first outline the routine tests carried out on the various elements and the system as a whole.

Microphones

Microphones are of the electrostatic (condenser) or electromagnetic (ribbon) type. The high internal impedance of the condenser requires an associated amplifier close to the transmitter. The ribbon microphone amplifier may be similarly attached to the transmitter, or it may be some distance away, connection being made by means of a suitable cable.

In either case, frequency runs are regularly made on all microphone amplifiers after they are brought in from production and before they are again issued for recording purposes. For the transmitter is substituted a suitable oscillator input (range 60–6000 cycles) and the deflections of a thermocouple meter in the output of the amplifier are noted.

Microphones are also connected in circuit in the test room and allowed to "cook" with the current on for a period of about one hour. A skilled observer then listens in the output of each amplifier for noise. Through long experience, this man can generally tell the origin of disturbances by the way they sound and may localize noise in one of the coupling resistors of the amplifier, in the transmitter itself, or in some other element of the circuit. Quick diagnosis is necessary, since twenty or thirty units may have to be tested in a few hours.

Combined with the test for noise, there is a rough sensitivity check utilizing a watch placed at a fixed distance from the transmitter under test. With a normal amplifier, the output signal is comfortably audible in headphones. Inability to hear the ticking of the watch under these conditions indicates that the amplifier is not supplying the necessary gain. A loud signal, on the other hand, indicates a hypersensitive condition, which would probably result in tube bonging or other irregularities during movement on the stage. (It must be remembered that in motion picture recording, microphones are continually swung around to follow the movements of the actors, and quietness during such operations is essential).

The storage A and dry B batteries, which supply energy for microphones, are tested every day, since the least irregularity in this power supply will cause severe noise interference in the output of the recording amplifier.

Microphones are controlled through fader units, which contain six individual positions; two sub-gains, governing three microphones each; and one overall gain for the six positions. These are of the well-known T- or H-network type, resistance controlled. When one of these units has been out of use for two days or more, before it is put back in service the variable resistors are cleaned with carbon tetrachloride, all connections tightened up, and the unit is tested in all six positions with a normal recording amplifier for quiet operation. A resistance bridge is used in testing for grounds, resistance irregularities, etc.

A-, B-, and C-voltages are measured each day with the battery supply under normal load, and all plate currents are checked. At intervals of about one week, connections are tightened up and the amplifier receives a general overhauling, tubes being changed wherever indicated, etc.

Noise reduction amplifiers

Noise reduction is accomplished in the RCA system by blocking light from the unused portion of the track.[1] Measurements similar to those on the recording amplifier are made on the noise reduction amplifiers and the sensitivity is carefully checked, since the ability of the shutter to get out of the way of the modulation peaks depends jointly on its dead clearance and on the amplification of the amplifier which feeds it.

The edge of the electromagnetic shutter which blocks the undesired light is checked for vertical position by means of a scale. The minimum clearance is set on an optical target to correspond to 5 mils on the film. That is, the shadow of the shutter is 5 mils from the zero modulation beam, as shown in Fig. 2 (left). The gain of the noise reduction amplifier is then adjusted by means of a grid bias control so that the shutter clears the track 100 per cent when the modulation rises to 40 per cent of the full track. This is shown in the right-hand half of Fig. 2. The shutter must be sensitive enough to move appreciably for a modulation of 2 per cent, the input switch to the system being turned on and off so that this movement, or its absence, may be noted by the operator. All these observations require a hand-magnifying glass of five- to eight-power size.

A variable area film recorder consists of a constant source of light which, through a suitable condensing lens, illuminates the mirror of an oscillographic galvanometer fed by the recording amplifier. The vibrations of this mirror cause proportional variations in the position of the reflected beam directed on the moving film through a microscope objective, which includes an optical slit; a variable area track is the ultimate result.

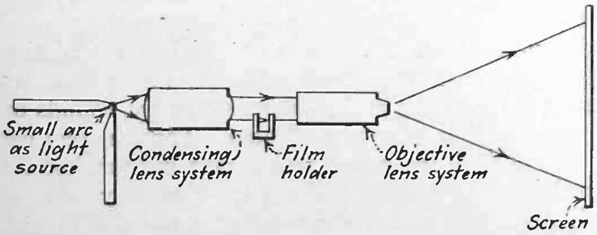


Fig. 4—Micro-projector for examining sound track

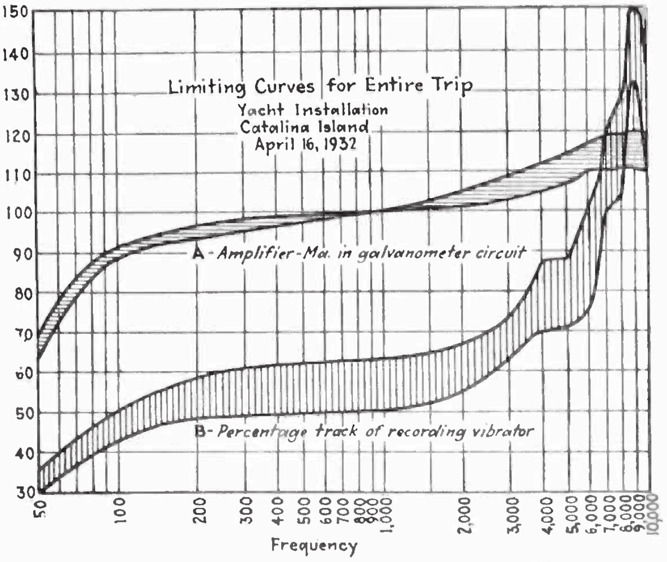


Fig. 5—Limiting curves for recording amplifier and vibrator

A daily mechanical check is made on each film recorder before it is used commercially. The *sine qua non* of a good film recorder is constancy of motion of the film past the recording light. This is checked by a specialist who runs a length of film through the machine, notes the adjustment of the take-up, the functioning of the various shrinkage compensating mechanisms, the action of rollers and sprockets, etc.

Optical checks include a photometer reading and observation of the position of the recording light on the film. The latter can be gauged to within 2 mils by an experienced observer who notes the distance between the edge of the light and the sprocket perforations. The photometer is a means of comparing the illumination of the excitation lamp of the recorder, with that of a standard light source. The former provides an illuminated field which varies in luminosity as the current through the excitation lamp is changed. The current is set at a point where the field and the central standard spot merge in the photometer.

The recordist monitors by ear through a loudspeaker in the recording booth. The loudspeaker level should be standard for all booths, so that as the company moves from one stage to another the operator will not be deceived by random changes in level. It would be difficult to measure the acoustic output of a speaker for a standard signal, but this is not found essential as long as loudspeakers of one type are used and maintained in normal condition. Setting of the current in the voice coil of the loudspeaker for a standard input satisfies the requirements.

In some types of recording equipment, the operator, while manipulating his microphone controls and listening to the monitoring speaker, is in a position to see the width of the modulation on the recorder. In other cases, the recorder is in a remote location, whence, in order to provide a visual check of the modulation and avoid insufficient amplitude or over-shooting, it is necessary to provide an auxiliary indicator. This consists of an oscillographic galvanometer similar to the recording unit, the reflected beam, however, appearing on a calibrated glass instead of reaching a film.

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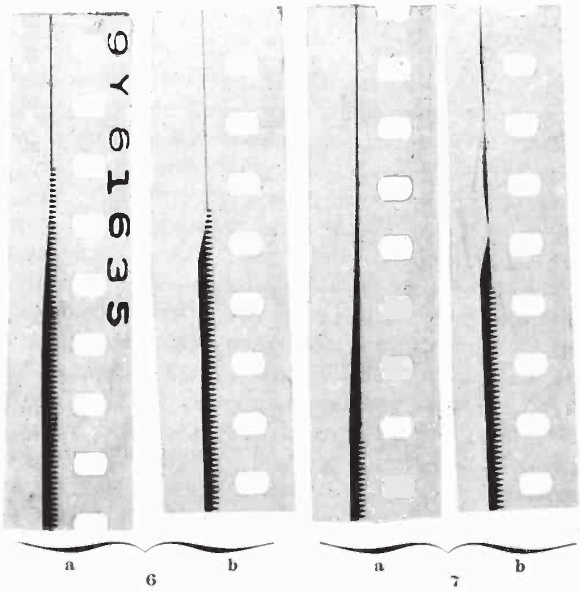
[1] "Progress in Sound Picture Recording," Carl Dreher, *Electronics*, March, 1931, page 542.

This optical indicator is calibrated against the recording vibrator by means of a variable shunt resistance. With a constant input from an oscillator at a standard frequency (1000 cycles) the amplitude indicator is set to read the same degree of modulation as that on the film. The correspondence is checked at 100 per cent track, 75 per cent, 50 per cent, and 25 per cent.

Overall frequency characteristics

An oscillator is arranged to give constant voltage to the fader at frequencies between 50 and 10,000 cycles. With signal on, the resistors on the individual faders are first "scrubbed in" to remove minor particles in the mechanism capable of causing noise later. The output current is then read on a thermocouple meter of the same impedance as the galvanometer circuit, connected across the output of the recording amplifier. This gives the upper curve in Fig. 3. Next, the resonant peak of the optical amplitude indicator (middle curve) and that of the recording vibrator are measured. It will be noted in Fig. 3 that the amplitude indicator resonance is about 5300 cycles, while that of the recording vibrator is about 8800 cycles. The object of the latter is to permit recording up to about 10,000 cycles on the film, whereas the optical indicator resonance is not particularly important as long as the two curves coincide at 1,000 cycles.



Figs. 6 and 7—Sound film negatives showing shutter action

Whenever the recorder is loaded with a new roll of film, the first ten feet are exposed without modulation and sent to the film laboratory for development in advance of the rest of the roll. The laboratory reads the density before proceeding with processing of the sound track. Thus, if the film is by any chance underexposed, the advance strip will indicate the fact to the laboratory operatives, who then run the roll through the developing "soup" at a lower speed, enabling it to come up to the standard density of 1.5 generally set for variable area negative. Should the film be over-exposed, its passage through the developing solution will, of course, be accelerated correspondingly to avoid excessive density, with a high fog factor, etc.

A sort of stereopticon arrangement, shown diagrammatically in Fig. 4, is used for inspecting film sound track. This merely involves a source of light, such as a small arc lamp, which throws an image of the track magnified about one hundred times on a calibrated screen. A 70-mil sound track, under these conditions, has an amplitude of 7 inches on a screen a few feet from the lantern, permitting close checking of track placement, printer irregularities, filling in of high-frequency valleys by over-exposure, etc.

The finished negative is carefully inspected at the laboratory, beginning at about 6:00 a.m. on the day following exposure. Density, track placement, clearanceance of noise reduction shutter, etc., are noted. Thus, if there is anything wrong it will be known to the sound supervisors before another day's shooting starts, and necessary adjustments can be made. Prints are inspected as soon as available later in the day for track placement, density, etc.

Figure 5 shows the limits within which proper maintenance routine will keep the characteristics shown individually in Fig. 3. The amplifier, as shown in *A*, changes its state very little. There is more variation in the curves of *B*, which involve vibrator peaks, since these are affected by temperature, the height of the peak, referred to the 1000-cycle amplitude, increasing with the temperature.

The above list of tests, while not intended to be comprehensive, includes most of the routine maintenance operations of a major studio. Some of the test results are confined to the specialist who makes them. These are of such a nature that, once a reliable routine has been established, its proper carrying out may be left to the man delegated to it. The supervising engineers, however, receive copies of characteristic curves, as shown in Fig. 3, of all stage or mobile equipments to be used on a given day. They also receive reports of the results of the laboratory measurements on the sensitometric strips, and any irregularities disclosed by the negative and print inspection are likewise immediately brought to their attention. Thus many hours of work on the part of perhaps a dozen specialists are compressed into graphs and quantitative data which may be read in a few minutes by the technicians in charge. These curves and figures show that the maintenance routine is being properly followed, and if there are any irregularities their magnitude may immediately be noted.

It was stated at the beginning of this article that nothing must be left to chance and no opportunity should be overlooked to measure the physical characteristics of the sound track. Experience shows this to be a basic fact. If neglected, it is only a matter of time before trouble will be encountered. For example, in the case of one studio, the routine of visually checking the negative and prints each day was overlooked. The sound supervisors merely listened to the film as it was run off in the daily "rushes." One day it happened that a sluggish noise reduction shutter was causing cutting of low modulation peaks. By chance all the low modulation in this day's work was traffic noise. Of course traffic noise, even with the peaks cut considerably, sounds much the same as if it were unmutilated. Thus, merely listening to the film, the sound technicians did not know that anything was wrong. The following day, the same equipment was used for recording some low amplitude dialogue, and the shutter, continuing to cut peaks, caused

[*Please turn to page 22*]

Inter-carrier noise suppression

A new system

By NORMAN E. WUNDERLICH

THE method of inter-carrier noise suppression to be described below is a simplified system which requires no additional tubes and hence is much less expensive than more complicated systems, although performing the same functions. These results are attained by taking advantage of circuit arrangements made possible by the strategic electrode construction of the Wunderlich B tube which has a longer cathode and a small additional anode placed at the top of the structure and shielded from the other elements. By this extra anode, the AVC potentials are amplified before being applied.

Performance curves show the "threshold" level of the receiver may be set to any desired value while retaining the AVC action. The sustaining action of the AVC may be caused to release at any desired, lower signal level. The point of release may be adjusted by means of the sensitivity control. This action is very sharply defined because of the fact that the potentials applied to the automatic control system are amplified to just the correct degree. In addition to the advantage of sharply defined releasing action for noise suppression, the circuit makes it possible to handle high signal input levels without overloading the 2nd detector or preceding tubes.

In carrying out the amplified AVC control, the cathode of the detector is approximately 100 volts negative with respect to ground. This may be done by placing the speaker field winding in the negative return of the power system, as shown in the circuit diagram. If the drop of potential across the speaker winding is more, or less, than 100 volts, R_1 and R_2 are changed so that the drop across them due to the plate current will just equal the drop across the field winding, when no signal is being received.

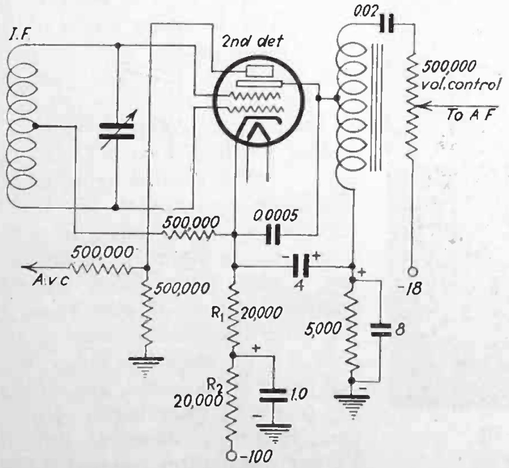


Fig. 1—Circuit of the new amplifier AVC system

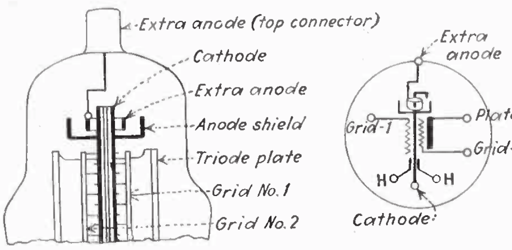


Fig. 2—Construction of Wunderlich B tube

The plate of the detector is preferably connected through the primary of a 1:2 step-up, center-tapped audio choke having a d.c. resistance of about 5800 ohms total winding, to a point in the power supply which is approximately 100 volts positive with respect to ground.

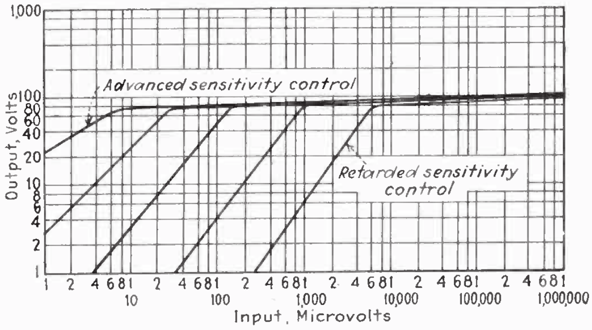


Fig. 3—Performance curves of 7-tube super-heterodyne

The use of an iron core step-up auto-transformer serves two purposes; (1) it increases the a.f. potentials applied to the output tube and (2) it increases the potential variations across resistors R_1 and R_2, thereby sharpening and increasing the action of the AVC system.

With no signal the potential drop in the tube plus the potential drop in the primary of the auto-transformer approximately offset the drop of potential across resistors R_1 and R_2. As the drop in these cathode resistors is approximately equal to and opposite in polarity to the drop across the speaker field winding to which it is connected, there is no difference of potential between the cathode of the tube and the chassis ground. In other words, the cathode of the 2nd detector will be "floating" at about ground potential. The extra anode will be at the same potential except that it will act as a one-way valve to permit passage of negative potentials for the AVC bias on the grids under control.

When a signal is tuned in, the grids of the second detector act as a full-wave grid rectifier and become negatively charged with respect to the cathode. This lowers the plate current through the resistors R_1, R_2, causing the cathode to become negative with respect to ground, and placing a negative AVC voltage upon the grids of the tubes under control. The AVC potentials thus obtained are greater than the rectified signal voltage. This makes it possible to have amplified AVC potentials which are high enough to control the strongest local signals without overloading either the detector tube or any of the tubes preceding it.

HIGH LIGHTS ON ELECTRONIC

Daylight control of factory lighting saves electricity

At the Chisholm Ryder Plant, Niagara Falls, photoelectric control of lighting saves 4,000 kw.-hours monthly, reduces lamp replacements one-fourth, improves production and reduces accidents.

By having a photo tube gage the intensity of daylight, the lights in the plant are automatically turned on during dark cloudy hours and later extinguished when daylight returns to normal intensity. At the Chisholm Ryder Works approximately 15 foot-candles of light intensity is maintained on the benches of tool-makers and on machine tools, the lighting of the entire plant being governed by changes in this level of illumination. When the natural illumination drops to 14 foot-candles, owing to morning or evening darkness or a passing cloud, the lights come on automatically and stay on until the daylight has raised the foot candles to 20.

As happens in practically all industrial plants with manually controlled lighting, workmen invariably left the lights on after the natural light had raised the intensity far above that required for artificial lights. For example, on dark days, workmen reporting at 7:00 in the morning turned on the lights and did not turn them off until after 8:30, thus causing the lights to burn needlessly for nearly an hour. With photoelectric control, the lights burn only when needed, greatly increasing their life. Previous to the installation of "day-light" control the Chisholm Ryder plant used 1,200 lamps a year whereas now 900 to 1,000 are sufficient. Energy consumption is 4,000 to 5,000 kw. hours less a month.

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Newspaper measures opacity of paper stock

The officials of the New York Daily News had the problem of detecting, before their papers were printed, whether the ink would show through enough to disturb the reader. Then Captain MacFarlane and Mr. Baumrucker developed an opacity meter using a Weston photronic cell, a microammeter and an ordinary 100-watt lamp. With this equipment, they have already classified over 500 samples of newsprint.

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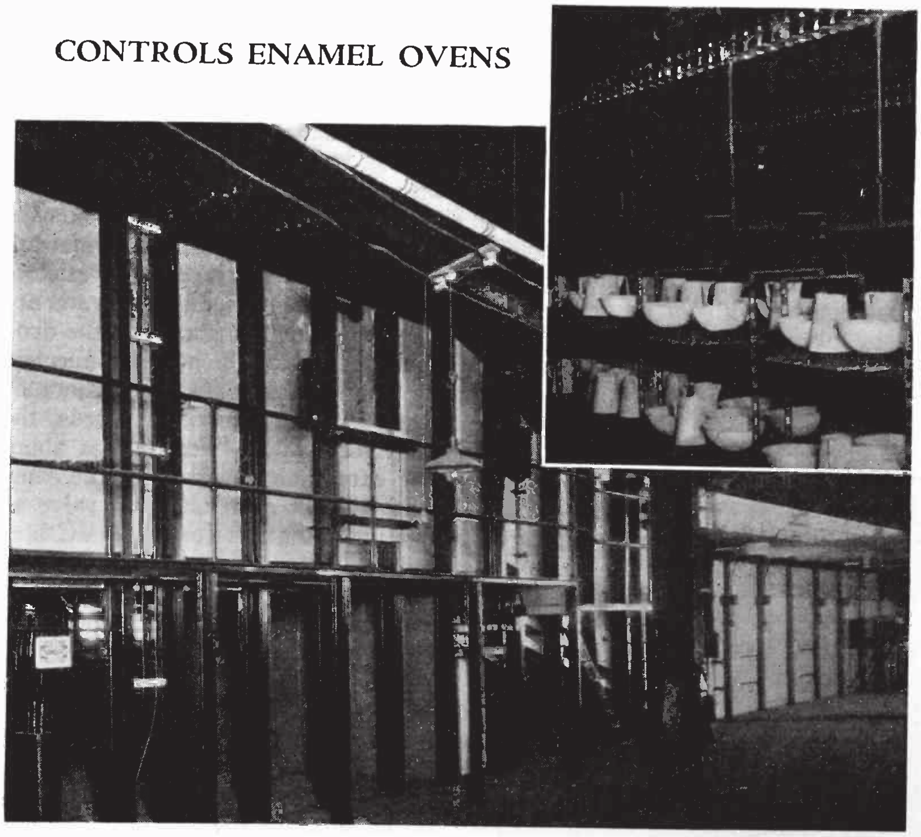
CONTROLS ENAMEL OVENS



The National Enameling and Stamping Company, Granite City, Ill., employs photocells to control metal-ware entering its automatic enameling ovens, which insures uniform heat treatment

Stroboscope inspects high-speed printing

The Edgerton stroboscope, recently described in Electronics (page 220, July, 1932), has been applied by the General Radio Company, Cambridge, Mass., in determining the register of color printing as it is speeding through the presses. Its usefulness is in "stopping" the motion of color printing as each color is applied. The application, of course, is only to rotary presses, such as are used for printing comic sections and long-run magazines.

In operation, a suitable make-and-break contact is fastened to one roller of the rotary press, which will flash the stroboscope as each sheet goes by. This will, of course, give the effect to the eye of the sheets standing still and the register of the color can be determined and adjusted when necessary. Similarly, the device can be used in determining the register of ordinary black-and-white printing.

Another application which the printing industry will find for the stroboscope is in stopping the motion of any of the high-speed machinery used to determine if the various parts in operation are working properly. Effects such as vibration and the action of rollers and cams can be studied with the machinery operating.

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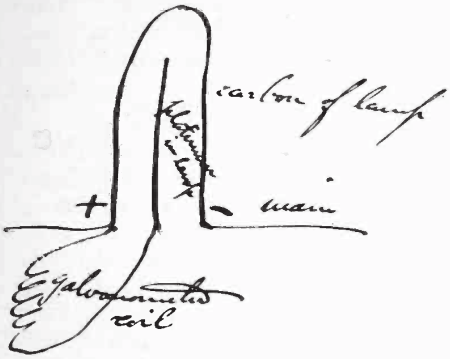
Counting crates on conveyors

The Canada Dry bottling works at Boston makes use of a photo-cell installation to count the crates of filled bottles as they go out to the shipping room. Ordinarily crates or boxes on conveyors are placed end to end, so that the line is too solid,—too continuous for counting. This conveyor, however, has a transfer from one belt to another, and as the boxes make the change, they are tipped first one way, then in the reverse direction. The resulting angle of light between boxes passing over the peak at the transfer point, provides just the place for installing the photo-cell beam, and so an accurate count is made.

The Sheffield Farms Dairy Company has solved a similar problem on a flat continuous conveyor, by inserting a high roller in the conveyor at the point where the photocell is to do the counting. This high roller interjects an angular interval of open space between the closely following boxes as they pass over it. Through this space, the photo-cell beam is projected, and so the counting proceeds, unfailingly. During a recent Saturday morning this Sheffield Farms installation counted 3,600 crates each containing twenty bottles of cream.

DEVICES IN INDUSTRY + +



The first industrial application of electronics?

Dr. Frank J. Sprague's 75th anniversary, recently widely celebrated, has recalled many early developments in electricity, not the least interesting of which is his own experiment with an electronic voltmeter in 1883.

Dr. Sprague had been in Brockton, Mass., in charge of the first underground three-wire Edison station (and it was in Brockton that he was also busying himself at this time with his first industrial motors), when the Pearl Street Station in New York failed, due to an overloaded feeder in the Stock Exchange quarter of the city resulting in a successive failure of "safety catches."

He had already begun his investigation of the laws of electrical distribution for two- and three-wire d.c. systems, and had developed a mathematical method for determining their proper values. This work incidentally was the foundation of his later complete fundamental design of overhead and underground distribution systems in use today.

On hearing of the failure at Pearl Street, he telegraphed his opinion of the trouble, and Edison promptly called him to New York to solve the overload difficulties, which he did successfully. About this time he apparently took up the development and test of the first real electronic potential indicator, as shown in the reproduction of Dr. Sprague's original sketch, which was made on December 27, 1883.

His own description of the indicator in a letter of that date written to this friend and associate William J. Hammer, at that time chief engineer of the Deutsche Edison Gesellschaft, Berlin, is as follows:

> "Then I went on to a new pressure indicator—a daisy founded on an old discovery of E's (Ed. Note—Edison's well known 'Edison effect'), thus. "With above connections (see sketch) of this special lamp, no appreciable current will flow through the galvanometer coil across the platinum to the carbon until a fair incandescence is reached, and then the current increases very rapidly. Hence the indicator shows no deflection until you wish it to, and then it begins to move rapidly. It has fine adjustment and is so sensitive that if 1/100th of the lamps be thrown off it will show the change in pressure. Its sensitiveness can be made more or less."

The accompanying sketch shows a typical diode comprising a platinum anode with the galvanometer coil in series, the anode voltage being supplied by the positive side of the d.c. lighting system. The negative leg of the carbon lamp filament acts as a cathode when incandescent.

Dr. Sprague does not recall other than an experimental use of this device—but it is nevertheless of interest as one of the forerunners of the present day vacuum tube.

◆

Stroboscopic testing of meters

To make the testing of clocks and meters as simple as setting a timepiece, a portable stroboscopic-meter method has been developed, which brings laboratory accuracy into field testing.

In meter testing, for example, the problem is to obtain an accurate comparison of two-meter disc speeds, one that of a standard meter and the other the speed of the meter under test.

The stroboscopic principle depends upon the phenomenon of a uniformly-rotating device, illuminated by a series of instantaneous flashes, appearing stationary if the rate of flashing is equal to the rate of rotation; "moving forward" if the rate of rotation exceeds that of the flashes and appearing to move backward if the rotation is slower than the flashing.

To use the new Westinghouse standard, the meter element is connected in series with the meter under test, both being connected to the same load. The incandescent lamp in the tester is lighted and the neon lamp is placed near the disc of the meter being tested, so that its light strikes the disc.

Light from the incandescent lamp is broken into pulsations by passing through notches in the revolving disc of the standard meter. These pulsations strike the phototube and are transmitted to the neon tube through the amplifier. Therefore, the neon tube flashes in synchronism with the disc of the standard meter and the disc of the meter under test, being seen in this flashing neon light, appears stationary if it is in perfect synchronism with the standard meter. Thus to calibrate the meter it is necessary merely to adjust its speed until the meter disc appears to stand still.

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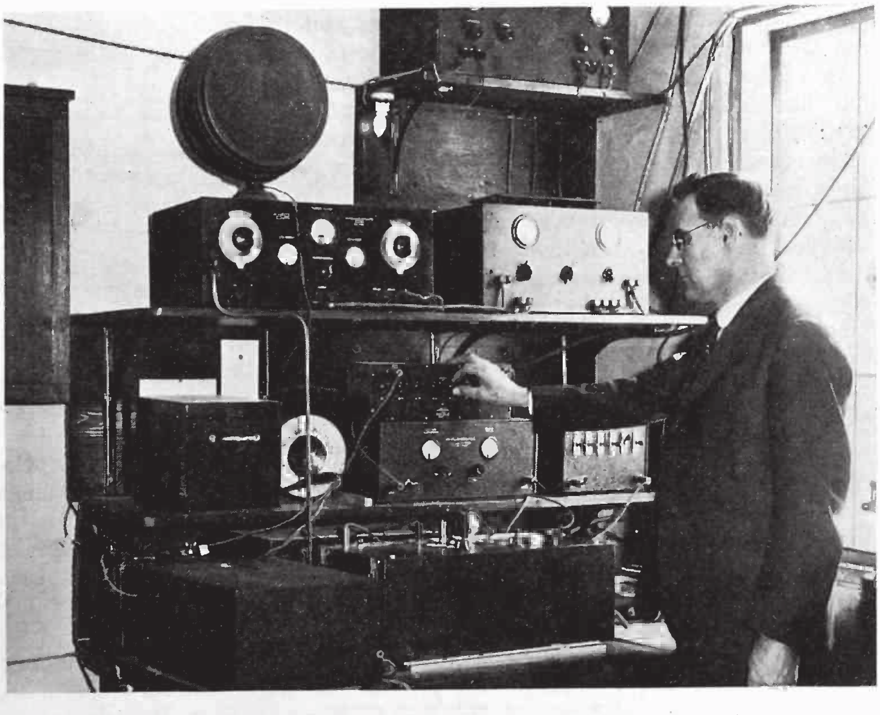
MEASURING SOUND ABSORPTION



V. L. Chrisler of the Bureau of Standards, Washington, with his apparatus for measuring the sound absorption of various building materials, at any required frequency

Circuits for amplified automatic volume control

An interesting circuit development making use of the possibilities of the 55 tube has been worked out by L. E. Barton of the RCA Victor Company, and independently by C. Travis of the RCA License Laboratories. In this circuit the steady d.c. voltage generated by the diode detector is amplified in the triode unit of the tube along with the detected audio frequency signal, and used as an AVC bias after this amplification. There results a very sensitive and level AVC system.

The advantages to be gained by thus amplifying the AVC bias appear from the following considerations. It is found that when the bias taken directly from the diode is undelayed the resulting control is not sufficiently flat, due to the fact that bias begins to build up as soon as any signal whatever appears at the detector, and thereafter can only increase by virtue of a proportionate increase of the detector input. If for example, a certain input at the antenna develops 5 volts bias and another stronger one raises this to 20 volts, there is necessarily a 4:1 increase in the output of the receiver if the modulation is assumed to be the same in each case.

To remedy this condition delayed AVC systems are employed, in which no control bias appears on the r.f. grid returns until the amount of the delay voltage is overpassed. Thus, referring again to the above example, if a delay of 40 volts is introduced, the receiver output changes in the ratio of 40+20 to 40+5, or there is a 4:3 change instead of the original 4:1 change without delay. It is apparent that the greater the delay voltage used the flatter will be the AVC characteristic.

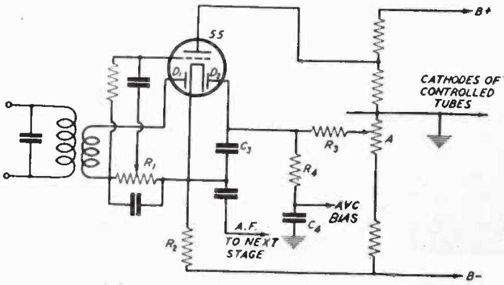


Fig. 1—Circuit for amplified automatic volume control

The antenna input necessary to overcome the delay voltage and bring about threshold conditions is in direct proportion to the magnitude of the delay voltage. Hence increasing the latter to obtain a flat AVC characteristic is done at the expense of the threshold sensitivity of the receiver unless the gain of the r.f. amplifier is increased at the same time.

As far as AVC action is concerned, the d.c. amplification of the controlling bias is equivalent to a corresponding increase in the r.f. gain of the receiver and this increase may be used as desired to make the AVC characteristic flatter or to increase threshold sensitivity, or both. The increase in gain possible is very nearly 8 for the 55 tube, so that the threshold may be moved down to an antenna input of one-eighth of what it was without the use of d.c. amplification, the delay voltage remaining the same, or, on the other hand, the delay may be multiplied by 8 for the same threshold.

The circuit is illustrated in schematic form in Fig. 1. The diode D_1 acts in the ordinary manner as a detector, the detected d.c. and a.f. voltages appearing between the cathode and the triode grid. The amount of the a.f. thus taken off is variable if so desired by the use of a potentiometer for the leak resistor R_1 as a manual level control.

As the triode has a resistance load the d.c. is amplified equally with the a.f. or by nearly the μ of the tube. By placing the load resistor R_2 in the cathode leg instead of in the more usual position in the plate leg, the d.c. output has the proper polarity to operate as a control bias for the r.f. amplifier.

The voltage delay action is produced by the second diode plate D_2. This is connected through the large resistance R_3 to the point A of the voltage divider, the potential of A being that of the minimum bias for the controlled tubes. The AVC bias is then taken off not from the cathode but from this plate D_2, through the filter R_4C_4. With no signal the cathode is considerably more positive than A, the difference in potential representing the delay voltage. With incoming signal the cathode becomes more negative, finally reaching the same potential as A, at which time D_2 begins to draw space current. Thereafter as the cathode goes still more negative D_2 follows it in potential, for the internal resistance of the diode is very small compared to R_3. As D_2 goes negative with the cathode the controlled grids are given increasing bias and the desired AVC action takes place.

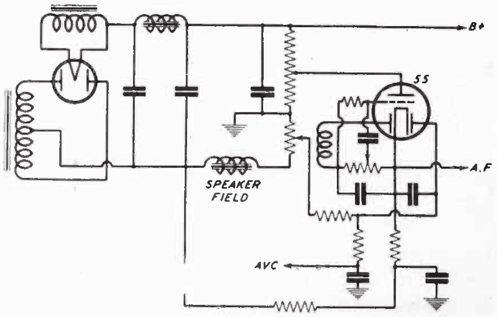


Fig. 2—Method of getting negative potential by using loud speaker field winding

D_2 is bypassed to the cathode for a.f. by the condenser C_3, so that the plate D_2 follows at all times the a.f. variations of the cathode. Hence when space current is

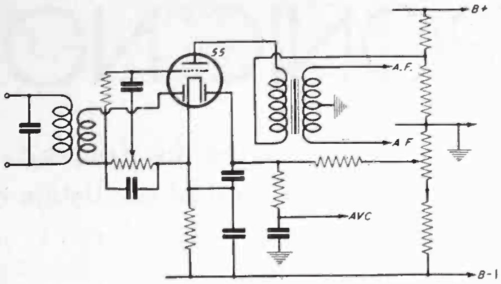


Fig. 3—Coupling the AVC-detector tube to push-pull tubes via transformer

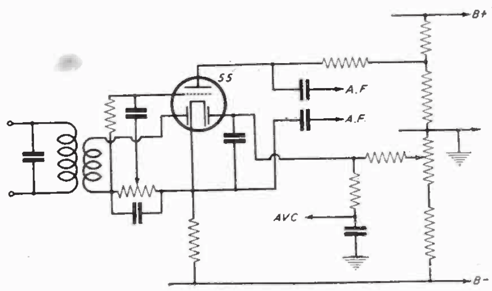


Fig. 4—The input push-pull transformer may be dispensed with in this circuit

drawn by this plate it is drawn uniformly over the audio cycle. This renders the generated AVC bias independent of the modulation, and eliminates the possibility of distortion that might occur if the space current were drawn only on the peaks of the audio cycle.

It may be desirable to make the potential of *A* variable with respect to the cathodes of the controlled tubes, as shown in the figure. This provides a means of controlling the sensitivity of the receiver.

The delay voltage, or the potential of the cathode above *A* for no signal input, depends only to a small extent upon the value of the cathode resistor, but is determined largely by the location of the plate connection to the *B* voltage divider and the resulting plate voltage. Changing tubes produces a variation in cathode voltage of the order of several volts, so that with an average delay of 50 volts or over the extreme variation to be expected from this cause is about ±10 per cent, which is quite unimportant.

A practical circuit arrangement

The most usual form that the circuit would assume in an actual receiver is probably that shown in Fig. 2. Here the necessary negative potential to ground is provided by the drop across the speaker field, which is placed in the negative leg of the power supply, still acting as a choke in this postion. Owing to the hum voltage that appears across the speaker field, additional filtering of the plate circuit of the 55 tube will probably be found necessary, inserted at the negative end of the cathode resistor as indicated in the figure.

In Fig. 1 the a.f. signal is taken from the cathode of the 55 through a blocking condenser, the grid of the next tube being biased through a leak in the conventional manner. Other methods of coupling may equally well be employed. Fig. 3 shows the use of transformer coupling. In this circuit the cathode resistor is by-passed for a.f. and acts as a d.c. impedance only.

If push-pull output without transformer coupling is desired the modification of Fig. 4 may be used. A pair of '47s can be driven to full grid swing in this manner with somewhat more than 20 volts peak carrier, 20 per cent modulated, at the detector diode, an input which is considerably less than that employed in many existing receivers to provide sufficient AVC directly from the diode. In this circuit half of the d.c. amplification is necessarily thrown away, but this is less important in view of the larger signal input. Thus in the example given 80 volts of AVC bias is available, all or most of which is used as a delay.

The indirect advantages accruing from the use of d.c. amplification are probably quite as important as the more apparent one that has just been discussed. It is regarded as conservative to say that the delay voltage should be at least as great as the bias necessary to control the strongest signal to be encountered. This gives a 2:1 rise in output from threshold to maximum input, and in the average receiver necessitates a delay of 30 to 40 volts. The diode driver (last i-f tube) is therefore called upon for an output of 60 volts peak carrier or more at the diode plate for the strongest signals, and at this output must drive two diodes, one for detection and one for AVC. At the threshold, the AVC diode places no additional load upon the driver, but as the signal strength increases the load from this source increases correspondingly.

A possible effect of the above is shown in Fig. 5. Here the performance of a certain receiver with direct AVC is compared with that resulting after the receiver had been changed over to employ the circuit described. The original AVC characteristic is shown by curve (1); it is seen that overload occurs at about 20,000 μ*v*, in the antenna. The delay employed in this case was 30 volts. With the new detector circuit, the delay used being 50 volts, curve (2) resulted. The threshold is now much sharper and has been lowered to 90 μ*v*, and for higher inputs the characteristic is a straight line, as nearly as it may be plotted, up to the highest input available, which was 700,000 μ*v*.

With the usual delayed diode AVC it is hardly possible to control the last i.f. tube owing to the high outputs required from it under the load conditions that obtain. With the new circuit the required output is reduced to one-quarter or one-eighth of its former value, the load is reduced to that of a single unbiased diode and more efficient coupling into this diode may be used, still further lowering the level at which the driver stage operates. It thus would seem that partial or possibly full control may be applied to this last i-f stage. Any increase in the efficiency of coupling between driver plate and diode is accompanied by a corresponding increase in the sensitivity of the receiver, as well as in the sensitivity of the AVC threshold.

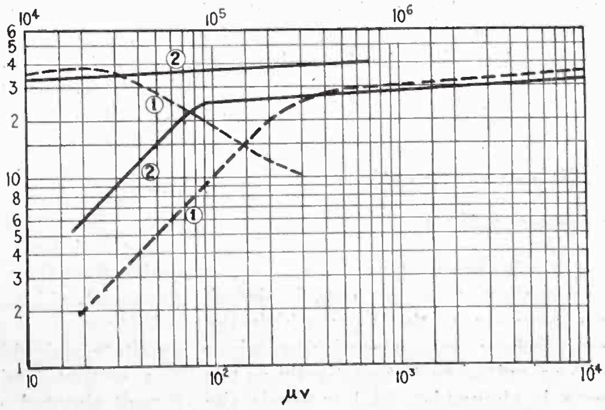


Fig. 5—Results of substituting amplified AVC for conventional circuit

+ + + ELECTRONIC NOTES

Cuprous-oxide rectifier life tests

IN TESTS MADE by H. Boehm of the Westinghouse Cooper Hewitt a full-wave rectifier to which 15 volts a.c. was applied was used for charging a twelve-volt battery. After 2,000 hours the charging current fell from 0.7 amp. toward 0.5 amp. (a drop of 27 per cent). After 6,200 hours the a.c. voltage was increased to 16.2, the charging current rose to 0.74 amp. and remained at this value for over a year. The current in the reverse direction increased from 0.3 to 3.3 per cent. A very remarkable advantage of this type of rectifier is that when with continued charging the potential of the storage cell increases, due to the drop in charging current the voltage drop increases at the same time. The internal resistance may be so chosen that the charging stops quite automatically. The rectifying circuit used was the Graetz circuit with four rectifying units. The work is described in *Elektrotechnische Zeitschrift, November, 1932.*

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New low noise vacuum tube

WHEN COMMERCIAL VACUUM TUBES are used to amplify small low-frequency voltages, disturbances of the order of 100 to 1,000 microvolts limit the minimum voltage which can be measured in the range below 100 cycles per sec. The causes outlined by G. F. Metcalf and G. M. Dickinson of the General Electric Company, are insulating material in or near the path of the electrons, irregularity in the emission of electrons, the presence of gas, deposits on grid wires, emission of positive ions. In the PJ-11 tube described in *Physics,* July, 1932, these effects have been reduced to a point where they are of the order of the shot effect, so that low frequency voltages of less than 1 microvolt can be amplified over the entire frequency band below 100 cycles (noise output of PJ-11 is 5 to 10 microvolts, 222 tube 52 microvolts, 240 tube 65 and 112-A 85 μv.).

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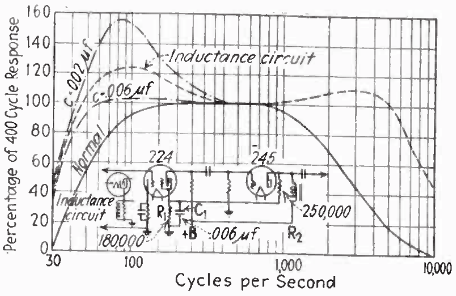
Fidelity compensation by regeneration

BY A. C. MATTHEWS

CONSIDERABLE INTEREST IS displayed, this season, in methods by which the low frequency response of a receiver can be raised, often automatically as the volume is changed. At low levels the peculiarity of the audibility curve makes decreased low frequency response unusually apparent. Other reasons for boosting the bass are the losses in degeneration in bias resistors, insufficient baffle area and general circuit losses.

The schematic shown below has been used with much success in compensating the low frequency response in an amplifier. The compensation is introduced in the screen circuit of a tetrode so as to not affect the otherwise normal frequency characteristic. A portion of the signal in the output circuit is fed back in phase to the screen-grid circuit. The resistors R_1 and R_2 are of such a value that the tube is operating with its normal d.c. screen-grid potential. Obviously an a.c. potential also appears (assuming a signal is present) across these resistors, part of which is applied between screen-grid and ground. The resistors should be of the order of 100,000 to 500,000 ohms so as not to draw too heavy a current or be an appreciable shunt on the output circuit. The condenser C_1 is of such a value so that it bypasses the higher frequencies. Increasing C_1 beyond a certain value will result in a low frequency oscillation. The value is not extremely critical however and an approximate frequency characteristic may be calculated at a given output level if the original fidelity is known. The impedance of the screen-grid circuit decreases with frequency thus the voltage fed back through the tube is greater for the lower frequencies. (Measurements indicate that the amplification factor between the screen-grid and plate under normal operating conditions is about twenty.)



This method of fidelity compensation actually adds to the fidelity curve and does not depend on the suppression of the other frequencies. Should it become necessary to compensate for the high frequency end of the audio characteristic C_1 is replaced by an inductance. This will result in more voltage being fed back at the high frequency end rather than at the low end and an appreciable hump will appear in the fidelity curve. Some requirements necessitate a double humped curve. This can be obtained by a series resonant circuit shunted across resistor R_1. The point of resonance of course may be shifted to suit the individual case.

Measuring the damping coefficient of oscillating circuits

THE CIRCUIT examined by V. Petrzilka and W. Fehr of the Heinrich Hertz Institute in which the frequency f_2 could be varied, was coupled inductively to a quartz-controlled tube which oscillated at a constant frequency f_1, and the current I_1 and I_2 was measured for different values of f_2. The half-width of the curve at $I_2^2/I_1^2 = \frac{1}{2}$ the resonance value when I_2^2/I_1^2 is plotted as a function of $1 - f_2^2/f_1^2$ is equal to the damping $R_2/6.28\,f_2L_2$, whatever the amplitude and the coupling used. The October, 1932, issue of *Zeitschrift für Technische Physik,* contains the paper by the German experimenters.

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The thyratron as an oscillator

IF IN CERTAIN types of thyratrons, such as the FG-67, the anode is connected to the positive side of a d.c. source through sufficient resistance, and a condenser in series with a small inductance is connected between cathode and anode, oscillations are set up in the anode circuit when current is allowed to pass. The oscillations according to H. J. Reich, University of Illinois, resemble those obtained in neon-tube circuits. The current can be permanently stopped if the grid is made negative while the circuit is oscillating. If load resistance is replaced by the primary of a transformer, a.c. may be taken from the transformer secondary (100 watts from 120 volts d.c. at 50 per cent efficiency). All these effects are based on the breakdown voltage being much higher than the operating voltage. The *Review of Scient. Instruments* for October, 1932, contains the data on Professor Reich's work.

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Practical vacuum-tube potentiometer

THE COMPTON ELECTROMETER having been found unsatisfactory, F. Rosebury, College of Physicians and Surgeons, New York, applied the low-grid, low plate voltage FP54 for pH measurements with glass electrodes. Galvanometer drift was reduced to a minimum by automatic compensation for filament voltage changes and floating of filament battery on a charging source. It is advisable, when first setting up the instrument, to test a batch of glass cells for potential drift; after some days the readings will be found nearly constant. The use of the FP54 is described in *Industrial and Engineering Chemistry,* October, 1932.

FROM THE LABORATORY + + +

Amplification at 7 meters

By enclosing the elements of two tubes in the same bulb, the Loewe vacuum-tube factory (Germany) has found it possible to get appreciable amplification at wavelengths of the order of 7 meters. The inherent capacity between tube elements has been reduced by this measure, and by sealing in the bulb the inductance and capacity used to couple the two tube elements together. Manfred von Ardenne writing in the *Hochfrequenz Technik und Electro Akustic*, August, 1932, describes these tubes which have a mutual conductance of 2000 micromhos. Two of them with 200 volts on the plate deliver an amplification of 100 over a band width of 500,000 cycles at 7 meters. This is sufficient for television reception.

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Long versus short broadcast waves

Studies on the comparative efficacy of frequencies in the present broadcast band made by Professor J. F. Byrne of Ohio State University show why broadcast stations are so desirous of getting assignments on the lower frequencies. Professor Byrne measured the field strength in Ohio of nine stations operating on various frequencies in the present band. These field strengths were then reduced to a common basis, that of one kilowatt of radiated power and therefore a picture was had of the comparative value of the longer versus the shorter broadcast waves.

The experiments did not take into account the conditions peculiar to the transmitter, i.e., ground conditions, steel buildings or other variables; it consisted merely in measuring the fields laid down in Ohio by these stations.

Professor Byrne's measured data showing that a one-kw. station on 1450 kc. will have a field strength of 0.2 millivolts per meter at 45 miles, on 1070 kc. the distance will be 75 miles, on 700 kc. the same field strength will be found at 110 miles, and on 550 kc. the distance will be 135 miles. Thus the distance is roughly inversely proportional to the frequency.

Other comparisons, as reported by Professor J. F. Byrne, show that to deliver 0.5 mv/m costs $2.06 per square mile of service area on 550 kc., $5.88 on 1070 kc. and $15.50 on 1450 kc. These costs are figured on an annual charge of $50,000 for a one-kw. station.

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Control by "non-linear" circuits

For some time work has been under way in the laboratories of the General Electric Company on the uses of non-linear circuits for purposes of control. Present circuits will cause a lamp to flash, dim, or brighten in any desired sequence or rate.

Other experiments have brought to light circuits which are oscillators or generators of alternating currents, more or less functioning like vacuum tubes. One circuit produces slow oscillations which will turn on and off an incandescent lamp several times per second or as slowly as once in thirty seconds, according to the arrangement of the circuit. Another oscillator has blinked a light on and off silently, without radio interference, and without wearing parts, approximately 100,000,000 times in the past two years while on life test in the laboratory.

Another oscillator produces relatively high-frequency alternating current. It was known for some time that high frequencies could be produced in transformers under certain conditions, but these frequencies are always multiplied or integral fractions of the frequency of the power supply. The new oscillator will produce any frequency in its range of usefulness; vibrations of 5,000 cycles per second already have been observed audibly in the laboratory.

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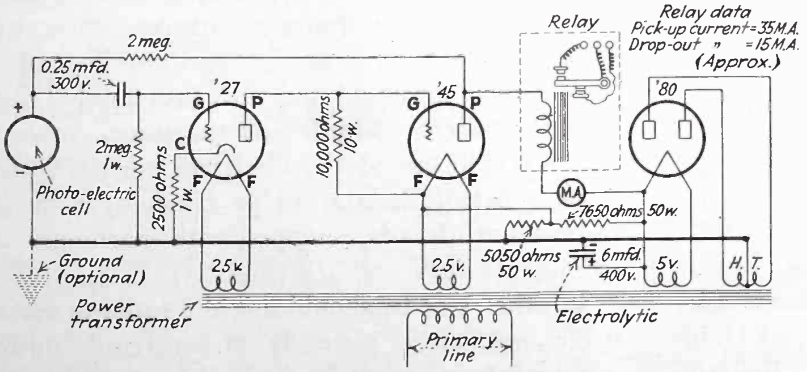


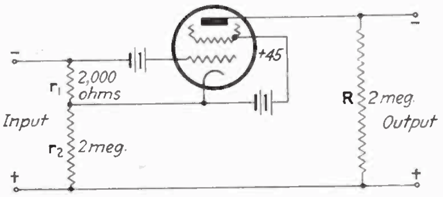
Circuit for operating a Square D contactor from a photocell through a two-stage amplifier

Still another application of non-linear circuits has been in resonance relays. Such relay circuits, which function because of "voltage resonance" and "current resonance" principles, are so sensitive that a voltage change of as little as 1/100th of one per cent will cause a current change of 100 per cent. Relays of this type are adjusted by changing electric constants rather than mechanical constants, and are therefore practically free from the effects of wear, friction, dirt, and extremes of temperature; the burden of accuracy is placed on a circuit, where accuracy may be obtained economically with perfect reproducibility.

✦

Thermionic tetrode voltage control

For small currents (0.01 microampere) but very constant voltage, the rectified a.c. from a transformer operating from the lighting circuit and controlled by a 24-A type tube is far more steady than a battery of storage cells of one ampere-hour capacity according to J. C. Street and T. H. Johnson of the Bartol Research Foundation. The voltage supply from the rectifiers is connected across two resistances r_1 and r_2 in series, the drop across r_2 being the supply voltage for the plate and that across r_1 for the grid. The description in the *Journal of the Franklin Institute*, August, 1932, states that for a variation of 60 volts in the input voltage (from 1580 to 1640 volts) the output voltage varied less than one volt.



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Photocell-amplifier circuit

An amplifier to be used with a photocell which will operate directly a Square D magnetic contactor capable of handling 20 amperes at 440 to 550 volts has been designed by Harry L. Kagamaster of Akron, Ohio. The circuit is given here and will be seen to consist of a very simple arrangement of apparatus which will control considerable amounts of power without any intermediate relay.

electronics

McGraw-Hill Publishing Company, Inc.
330 West 42d Street
New York City

O. H. CALDWELL, *Editor*

Volume VI — JANUARY, 1933 — Number 1

Technocracy's strength and weakness

READERS of *Electronics* have long watched with interest and concern the social and economic results of the mechanization of industry, which the Columbia University group known as Technocracy now seek to reduce to a statistical basis. Such statistics are needed, and Technocracy deserves credit for its double-stroke in putting unemployed engineers to work to get the facts on unemployment.

But Technocracy's interpretations, and the solutions proposed by individual Technocrats, will be examined critically, by engineers as well as by economists. They have their weaknesses. Even an "energy dollar" or an "electricity dollar" would be speedily demonetized, with the inevitable increasing efficiency of the photo-cell to utilize the 200 watts of free energy which pours down in every square foot of sunshine. Even the units set up by Technocracy itself are not impregnable against the ceaseless attack of scientific research and invention, which falls upon technocrat and plutocrat alike.

550 versus 1,500 kilocycles

AS A RESULT of a field-strength survey in Ohio of broadcast stations on several frequencies made by Professor J. F. Byrne of Ohio State University, and reported in its Bulletin 71, there is no longer any need or excuse for an ostrich-like attitude on the relative merits of frequency assignments at the two extremes of the present band. Although the research did not take into account unfavorable location of the transmitter, the results are most important.

Professor Byrne's studies conclusively prove "that the different frequencies in the broadcast band cannot be treated as equivalent, and that frequencies of 1,000 kilocycles or above are uneconomical for large coverage and high power. They also indicate that low power stations are at present wasting good low frequency assignments that are suitable for high power and large coverage. It is realized that the political problems involved in any contemplated changes are indeed difficult, but the engineering and economic solutions are clear and straight-forward; and if these solutions are kept in mind, time may solve the apparently insuperable difficulties of a political nature now existent."

Musical instruments— a new electronic industry

THE rôle played by the radio "fan" of a decade ago is well known; statistics show that hundreds of thousands of listeners were introduced to "music in the air" by home-made apparatus that furnished the thrill of hearing sweet music as well as the joy of making something with one's own hands.

Is it impossible that a new industry—that of electrical musical instruments — might not be built up in just this same manner? Might not the vast population, for generations more or less skilled in making its own music, grow tired of canned tunes, especially those selected by others? Might not people desire to express their own emotions on their own instruments instead of having their music diluted with talk handed them by advertisers? Might not the desire to build things create out of the electrical musical instrument a new fad, later to be taken over by the radio plant already equipped with machinery for its manufacture and distribution?

In other words, should not the radio manufacturer look more seriously at electrical musical instruments that can be built out of radio components by methods already in wide use?

News of the electronic field

Radio Forum discusses noise elimination—At the first Radio Forum conducted by the Radio Club of America at Columbia University, New York City, December 17, engineers discussed various methods of reducing extraneous noises picked up by radio receivers. Preceding the Forum, C. E. Brigham, chief engineer of Kolster Radio outlined the engineering attack made by his company on this problem. Contributions to the discussion were made by C. W. Horn, general engineer National Broadcasting Company; F. X. Rettenmeyer of the Western Electric Company; J. G. Aceves, for many years right-hand man in Professor Pupin's laboratory; C. J. Franks of the Radio Frequency Laboratory; and Keith Henney, associate editor of *Electronics* and editor-in-chief of the new McGraw-Hill Radio Engineering Handbook.

Photocell exhibit at Columbia University—Many examples of light-sensitive cells of both the past and present art have been placed on exhibit at the Physics Building at Columbia University. The collection has been made by Mr. Samuel Wein and is in charge of Professor Stone for the University.

Automotive and radio engineers cooperate—Thirty engineers of radio manufacturers held an important meeting Dec. 2, at Detroit on the development of automotive radio. The conference was directed by Chairman Virgil M. Graham of the RMA standards committee. Special work was accomplished on B power supplies of various types and work begun on standardized instruction for ignition suppression. A sub-committee was appointed to prepare specifications on the measurement of sensitivity in automobile receivers. Other sub-committees will cooperate with the automotive engineers' wire commitee on the subject of connecting cables for radio receivers and work on standard instructions for ignition suppression methods including a standard "suppressor kit" and instructions for car antenna installation.

Society for electronic music—The Berlin Radio Show brought to light such a deep interest in electronic musical instruments that a society has been formed in order to further the technical as well as the artistic side of the new movement. Among the founder members are: Prof. George Schuenemann, director of the State Conservatory; Prof. Dr. G. Leithaeuser of the H. Hertz Institute; Dr. Fr. Trantwein, inventor of the Trautonium; Carl Bechstein, builder of the Neo-Bechstein Grand Piano, etc. The secretary is W. Zerlett, Berlin W 57.

A. S. Wells, chief engineer of RMA—As A. S. Wells, president of the Gulbransen Company of Chicago was unanimously elected by the board of directors of the Radio Manufacturers Association to be chairman of the engineering committee, succeeding Franklin Hutchinson of New York who resigned. Mr. Wells will have charge of all engineering matters of the association. No changes in personnel of the engineering division, of which Dr. C. E. Brigham of Newark, N. J., is director, or its sections and sub-commttees, is planned. Mr. Wells also will have charge of the new RMA Engineering Institute and the new official RMA seal plan.

Joseph Henry's radio flash of 1840—During a tribute to Joseph Henry, early American scientist, who produced the first telegraph (1830) and the first motor (1831), and discovered electromagnetic induction and self-induction (1832), Henry's experiments with space radio across the Princeton campus in 1840, were demonstrated over the NBC Blue Network, Dec. 17. Henry's own description of his experiment follows: "When the discharge of a battery of several Leyden jars was sent through the wire stretched across the campus in front of Nassau Hall, an inductive effect was produced in a parallel wire the ends of which terminated in plates of metal in the ground in the back campus, at a distance of several hundred feet from the primary circuit, the building of Nassau Hall intervening. The effect produced consisted in the magnetization of steel needles."

Radio City's first broadcast—A four-hour program over the National Broadcasting System, Dec. 27, marked the first broadcast from the new $250,000,000 radio center, and signalized the opening of the two great music halls to be conducted under Roxy's direction. The Radio City Music Hall seats 6,200, and has elaborate lighting effects controlled by 4,100 switches. Thyratron dimmers are operated through selsyn motors from a centralized switchboard. Not until next September will the NBC studios be installed in Radio City, delay in beginning the manufacture of the apparatus having resulted from the Government suit. Production is now underway and installation will proceed during the summer.

Electronics, Volume Six—With this issue *Electronics* begins its sixth volume. This is the thirty-fourth consecutive number since the magazine first appeared in April, 1930. Following the usual McGraw-Hill practice of bringing the publication's history down to date in each January number, the members of the editorial staff who have been continuously with the paper from the first issue, are as follows. Orestes H. Caldwell, editor; Keith Henney, associate editor; Helen Sheridan, make-up editor.

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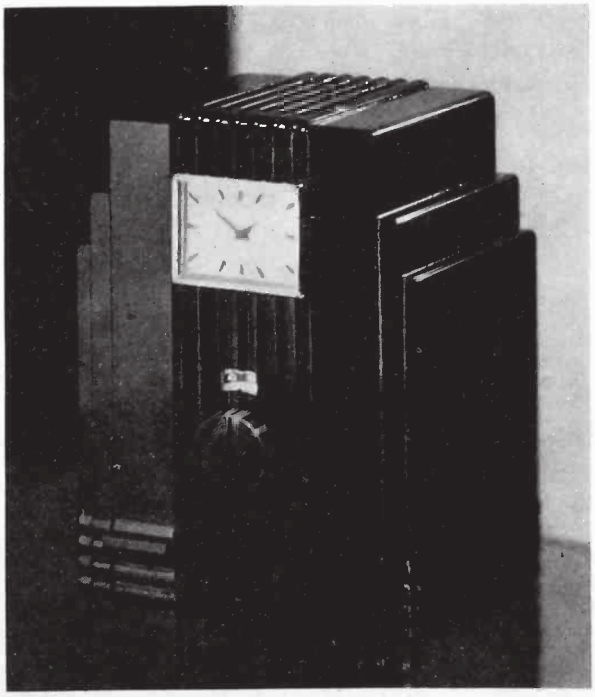
MIDGET, 1933 MODEL



Artistic, compelling design will be a force to sell more radio sets in 1933. Gone, the old "tombstone" lines, this attractive set was modelled by Vandoren and Rideout, Toledo

Tubes with cold cathodes

[*Continued from page 6*]

were made. In one case a single-tube demodulator made audible throughout the auditorium local broadcast programs. The signals were not loud but in another set employing a detector, a single audio amplifier followed by a stage of push-pull amplification, all using the glow-discharge tubes, the signals were comparable to present-day receivers. The volume corresponded to an output level of the order of several hundred milliwatts. The tubes had a distinct purple glow in them.

Following the demonstration, Mr. R. D. Duncan, chief engineer of Wired Radio, Inc., explained that the tubes were the result of the desire on the part of his company for radio receivers on which the service costs would be reduced to a minimum. Wired Radio, a subsidiary of the North American Company, has complete plans and apparatus for introducing a program service to the home by means of power wires on a rental basis. In such a system the company would bear the cost of servicing receivers, and tubes which could be integral parts of the receiver and not require replacement would be a distinct advantage.

Mr. Duncan intimated that tubes would be ready for the market within a reasonable period. Characteristics of the tubes will be available to engineers within a short while, he said.

▼ ▼ ▼

Control of sound quality in picture production

[*Continued from page 12*]

distortion which necessitated costly retakes. Had the tracks been visually inspected after the first day's work, the shutter difficulty would have been corrected before the equipment was again permitted to be used in commercial recording.

While judgment of quality, amplitude control, etc., are not materially different in picture recording than, for example, in broadcasting, the picture field has its peculiar difficulties. As in other forms of trouble shooting, experience constantly teaches one new peculiarities, some of an unforeseeable nature. For example, on some stages there is a certain amount of 50-cycle field which, when picked up by microphone cables or other conductors, affects the track as a wavy line or "snake," on which the rest of the modulation rides. Now, a 50-cycle note is not audible in a monitoring speaker, so that it is difficult to check its presence at ordinary amplitudes. As long as open tracks were used in recording by the variable area system, a few mils of 50-cycle modulation on the track were of no particular consequence. But when noiseless recording was introduced, with its microscopic spacing between the modulation peaks and the light blocking shutter, difficulties were encountered from this source. Thus it became necessary to introduce an additional check, which merely consisted in opening and closing the vibrator circuit, any movement indicating the presence of 50-cycle or other inaudible pickup. This indication corresponds to the key clicks heard in a radio receiving set which is picking up an unmodulated and unheterodyned carrier.

In coping with the unique problems of motion picture sound recording, the engineer takes advantage of the fact that his film recorder is in effect an oscillograph which can always be used to photograph its own action. Figures 6 and 7, which are reproduced from film negative, show the technique involved. Figure 6-*A* shows a noise reduction shutter moving out to accommodate modulation, but it takes 0.014 second to clear, and in this interval there is considerable cutting of peaks. In (*B*) of Fig. 7, the corresponding decrement is shown as the modulation ceases. In Fig. 7, a modification of the noise reduction amplifier has resulted in a more agile shutter action, so that only about 0.004 second is required for clearance, but it will be noted in (*B*) of this figure that in going back to dead clearance the shutter manifests a transient bouncing action which prevents it from dropping immediately to the minimum clearance. The illustration is typical of the methods used in checking the action of sound recording apparatus in a well-operated studio.

▼ ▼ ▼

A NEW BOOK ON AN ELECTRONIC SUBJECT

Electronics

By Ralph Gorton Hudson, Professor of Electrical Engineering, Massachusetts Institute of Technology. 135 pages, 45 illustrations, several tables. Price $2. Published by John Wiley & Sons, Inc.

In his preface to *Electronics*, a book dealing almost exclusively with the properties of electrons rather than the uses of electronics apparatus, Professor Hudson states, "it is quite probable that the advancement of science during the next quarter century will relate more definitely to electronics than to any other subject. Each step in the progress may be expected to suggest practical applications of electronics theory which will give man increasing control of the forces of nature."

The book is to bring the engineer, or other user of electron tubes up to date, in the matter of what electrons are, how their properties were discovered, what these properties are, what the atomic theory of gases is, the facts with respect to conduction in metals, in liquids and in gases, and theories of radiation and electron and photoelectric emission. The final chapters of this small book deal more with the practical uses of electrons in motion, and more nearly correspond with what many people understand as "electronics."

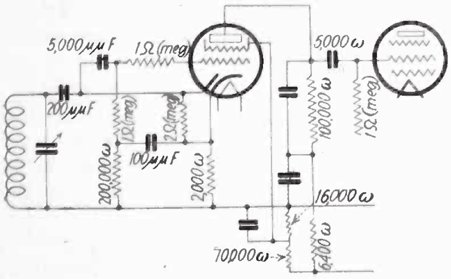
The book is without mathematics which is desriable, is sound, and in very small space undoubtedly covers a good bit of the ground leading up to the application of electron circuits. A better title would have been desirable; surely the single word "Electronics" is ambiguous.

REVIEW OF ELECTRONIC LITERATURE

HERE AND ABROAD

Philips binode tube

A NEW TUBE SPECIALLY for detection, essentially a combination of a diode as detector (small auxiliary anode close to one end of the cathode) with a screen-grid tube as amplifier. Amplifications of 70 to 80 times are claimed, in such a circuit as shown.—*L'Onde Electrique* (advertisement), Paris, September (published December 5) 1932.



✦

Vacuum-tube voltmeter with logarithmic calibration

[F. E. ROMMEL] Development Laboratory, Neufeldt and Kuhnke, Kiel. For many purposes, for instance the recording of sound intensities in decibels, the testing of loudspeakers and receivers, a vacuum-tube voltmeter with a logarithmic scale saves much time. In some of the variable-mu tubes the relation between grid bias and anode current is given by an exponential curve between —6 and —26 volt bias, while the plate current varies from 2 to 0.2 ma. By applying the potentials over a voltage divider the sensitivity of which can be varied ten or hundredfold, a good logarithmic scale of sufficient range can be obtained when using the best portion of the characteristic (bias varies in the ratio 1:2, current in the ratio 1:10). —*Hochr. u. El Ak. 40:124-126 (October, 1932).*

✦

Differential selenium obverse photocell

[L. BERGMANN] University of Breslau. A cut is made through the selenium layer and the metal film with which it is covered and each part is shunted by a resistance in order to give the same sensitivity to the two halves. The electrodes are so connected that no photocurrent flows when the two halves are evenly illuminated. In many measurements it is possible to throw light from one part of the measuring system upon one side of the double cell and light from another part upon the second half. Any change is indicated by flow of current. Changes in length can be measured if the object be made to vary the width of a slit which lets a strong light fall upon the line of separation. Small angles of rotation can also be measured by means of this very compact device.—*Zeits. f. techn. Phys. 13:568-573. November, 1932.*

✦

Television progress in Germany

[E. H. TRAUB] A review comprising a dozen pages and 19 figures dealing with the television receivers exhibited at the Berlin radio show with a handy list of transmitters and receivers. The Telefunken cathode ray receiver gave the best images. No details of the electrode arrangement could be obtained. The Telefunkn-Karolus Kerr cell receiver gave an image equal in size, brilliance and almost in definition to the 9.5 mm. home cinema, but the high voltages needed make the instrument unsuitable for home use. In the Loewe cathode ray receiver, about as good as that of Telefunken, the path of the ray is governed by a sweep circuit which is controlled by special synchronization signals, the tube gave a picture 9x12 centimeters. Mirror screws now being developed give clear images 13x15 cm. of films showing motor boat and bicycle racing.

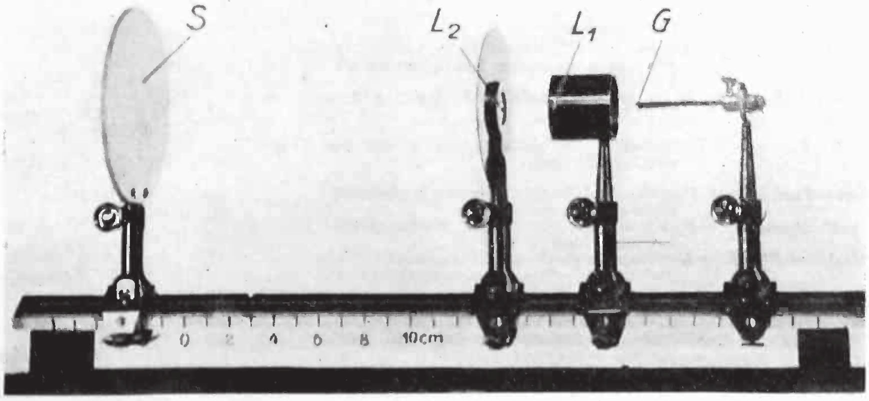
The 43,000 kc. 15-kw. transmitter was sending out a film daily during one hour in the morning and one hour in the early afternoon. The transmitter is described in *Fernsehen, Oct./Dec., 1932 —Journal of the Television Society, 1:155-166, September, 1932 (published November, 1932).*

✦

Transmitting tubes

[W. E. KUEHLE] Telefunken Laboratory. One progress made during the past four years in the construction of new transmitting tubes by Telefunken consists in the reduction in size of the tubes giving the same power. This was rendered possible by the introduction of hard glass which allowed the use of heavy lead-in wires so that the electrodes could be directly mounted on these wires and by a method of blackening the plate with a substance acting also as a getter in radiation-cooled tubes. Indirectly-heated cathodes can be used for powers up to 100 watts. A remarkable water-cooled tube is the 300,000 watt tube which has been in operation for some time (plate voltage 10,000) and which unlike the English giant tube (see *Electronics,* 1931) is completely sealed off. The full emission of 200 amp. is obtained with 800 volts on the plate (250 milliamp. per volt). The RS 282 is a 100 watt tube for 12 m. waves, the RS 291 for the same service is indirectly heated, the RS 296 gives 4 watts at 55 cm. in the Barkhausen-Kurz circuit (400 volts on the plate). A list of 34 tubes is given.—*Telef. Zeit. 13:5-19 (July) 1932 (published November, 1932).*

THE ELECTRONIC MICROSCOPE



The filament *G* sends out electrons, and when placed close to the diaphragm L_1, the opening in L_1 and L_2 act like lenses. An enlarged picture of the filament is produced on the screen *S* by the electrons themselves. The entire set-up is placed under a glass jar and evacuated. (See *Electronics*, December, 1932, page 377)

Hot cathode X-ray tube design

[W. R. Harper] University of Bristol. The body of the tube is a block of copper bored out at one side to take the filament, and from the other to take the water-cooling, the partition between the two chambers being 1½ mm. thick and serving as anti-cathode. The X-rays leave the tube through a window of nickel foil 0.015 mm. thick. Every part is as rigid as possible and an X-ray beam can be maintained constant to within 1 per cent over a period of several hours and reproduced.—*Cambridge Phil. Society Proceedings, October-December 1932.*

✦

Micro-waves

A micro-ray equipment has been ordered from Standard Telephones and Cables, Herndon, by the English air ministry for use in cross-Channel flying service. The equipment ordered will work on a wavelength in the neighborhood of 15 cm. (in place of 18 cm. —see *Electronics,* July, 1931). It will be located at Lympne airport, near Hythe, and will correspond to the outfit ordered by the French Air Ministry for St. Inglevert aerodrome seven miles southwest of Calais. Teleprinters will be used for both receiving and transmitting messages.—*The Electrician, p. 655, November 18, 1932.*

✦

Oscillating crystals

[Loest] Chiefly based on Haban's recent experiments. Various combinations are discussed, among which one of the most suitable was found to be a mixture of five parts of Mn_2O_3 to three to two parts of V_2O_5, both finely powdered so as to give a multiplicity of points of contact between the two substances, and the mixture pressed strongly between two steel electrodes about one millimeter apart. Such an arrangement is found to give a good and constant falling characteristic (negative resistance).—*Funk, Berlin, November 25, 1932.*

✦

Theory of gramaphone registration

[Gundlach] Mathematical treatment of the mechanics of disc-recording, especially from the point of view of the amateur.—*Funk, Berlin, November 25, 1932.*

Transient conditions and time-factors

[Rocard] Mathematical study of such conditions for the principal circuits used in radio, especially as applied to the setting up of a current in a series of tuned circuits (whether from a single impulse or a sinusoidal voltage); the same for a double circuit capacity- or inductance-coupled (band-filter type); time-constants in general and for certain important cases (tuned circuit, regenerative detector, transformer-coupled amplifier with tuned secondary, or with both primary and secondary tuned); action of a relay from an atmospheric arriving at the receiver. This last application is of special importance, giving striking results: for example, two circuits of the same number of elements and having sensibly the same selectivity may offer entirely different results as regards response to such disturbances.—*L'Onde Electrique, Paris, September (published December 5) 1932; and to be continued.*

✦

Amplitudes of sound from musical instruments

[K. W. Wagner] H. Hertz Institute. A small calibrated condenser microphone, corrected to give the same sensitivity between 60 and 10,000 cycles and followed by an amplifier, is used for measuring sound pressures from about 0.03 μ bar (about 1/300,000 grams per sq.cm.), the noise level of the Berlin broadcast studio, to over 150 μ bar (concert given by big choir) near the spot usually occupied by the microphone. During an organ recital the sound pressure amplitudes varied between 1 and 21 μ bar, during a piano concert from 0.06 to 14 μ bar, during a soprano solo from 0.08 to 25 μ bar, and similar results were obtained for string quartets and small choirs. For a large choir (250) and orchestra (110), however, there was a variation from 0.5 to 150 μ bars at 18 m. from the conductor. The maximum power developed by musical instruments is given as 0.006 watt for the violin, 0.06 for the flute, 0.27 for the piano, 0.3 for the trumpet, 3.5 watts on an average for the organ, 6.4 watts for the trombone, 12 watts for the drum and the deep registers of the organ, these values being in good agreement with American measurements.—*Sitzungsberichte preuss. akademie, No. XXV. November, 1932.*

✦

Industrial automatism

[Kloninger] General article: some uses of the photo-cell are given (the A.E.G. counting apparatus, a device based on a reflected ray for automatic train-stopping).—*Science et la Vie, Paris, December, 1932.*

✦ ✦ ✦

Electronics abstracts

In 1931 the Year Book of the Institute of Radio Engineers presented a list of some 60 periodicals of interest to radio engineers. Of these more than a dozen are written in foreign languages, and another dozen are scientific publications unlikely to fall into the hands of an engineer. Abstracts of the most important articles appearing in these periodicals are presented in *Electronics.*

Besides the periodicals given in the list a large number of trade journals and periodicals for the amateur are also published similar to *Wireless World, Radio-Helios, Funkmagazin, l'Antenne, Radio-Magazine, Radio per tutti,* etc.

Moreover, with the growth of electronic applications, descriptions of many devices using vacuum tubes appear in technical magazines, such as *Iron Age, Journal of the Textile Institute, Electrical World, Industrial and Engineering Chemistry.* Every attempt will be made to bring these articles to the attention of the readers of *Electronics.*

The periodicals can be consulted at any large library, and obtained through booksellers or subscription agents.

Abbreviation	Complete Name	Volumes in 1933	Editor and Price
Alta Fr.	—*Alta Frequenza,* Rivista di Radio tecnica, Telefonia e Acustica Associazione Electrotecnica, 10 via San Paola, Milano	2	Lire 30
Arch. f.Elek'rot	—*Archie für Elektrotechnik,* J. Springer, Linkstrasse 23-24 Berlin	27	Prof. Dr. W. Rogowski (Price variable)
E. N. T.	—*Elektrische Nachrichtentecknik,* J. Springer, Linkstrasse 23-24 Berlin	10	Prof. Dr. K.W. Wagner R. M. 48
Ferns, Tonf.	—*Fernsehen und Tonfilm,* Hermann Reckendorf Hedemannstrasse 24 Berlin	4	Dr. F. Banneitz R. M. 12
Funkt. Monatsh	—*Funktechnische Monatshafte,* Weidmann'sche Buchhandlung, Berlin S W 68	2	
Hochfr. u. El. Ak.	—*Hochfrequenztchnik und Elektroakustik.* Akademische Verlagsgesellschaft Markgrafenstrasse 6 Leipzig	41	Prof. Dr. J. Zenneck and Dr. E. Mauz R. M. 40
Onde Elec.	—*L'onde electrique,* Etienne Chiron, 40 rue de Seine, Paris (VI)	12	M. Mesny 80 francs
Phys. Zeits	—*Physikalische Zeitschrift vereinigt mit.,* Jahrbuch der Radioaktivitat und Elektronik S. Hirzel, Leipzig	34	Prof. Dr. P. Debye Prof. Dr. R. Seeliger $16.80
Revue ac.	—*Revue d'acoustique,* Les Presses Universalitaires 49 Boulevard Saint Michel, Paris (V)		T. Brillouin, etc. 150 francs
Telef. Zeit.	—*Telefunken Zeitung,* Telefunken Gesellschaft, 12 Halleschen Ufer Berlin SW 11	13	Dr. G. von Arco, Prof. Dr. F. Schroeter R.M. 6
Tijds. Nederland	—*Tijdschrift van het,* Nederlandsch Radiogenootschap 11 Elzentlaan, Eindhoven, Holland	6	
Zeitz. Exp. Ph.	—*Zeutschrift für Experimental,* Phonetik Joh. Ambr. Barth, 18 B Salomonstrasse, Leipzig	2	Prof. Dr. E. W. Scripture
Zeits.f.techn.Physik	—*Zeitschrift für technishe Physik* Joh. Ambr. Barth. 18 B Salomonstrasse, Leipzig	14	Dr. W. Hort, R.M.51

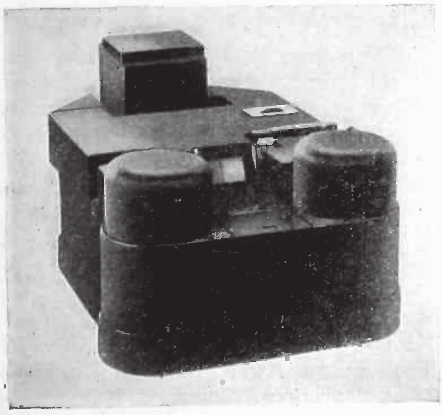
+ NEW PRODUCTS

THE MANUFACTURERS OFFER

Photoelectric scopometer

A new photoelectric scopometer is announced by the Bausch & Lomb Optical Company, Rochester, N. Y., for making turbidimetric and colorimetric measurements with greater speed and greater accuracy. It dispenses with the human eye for making the delicate color matches and notation of disappearance points, thereby giving it a combination of speed and accuracy otherwise impossible. Furthermore it is extremely simple in its operation.

The human eye is affected from hour to hour by physiological and psychological conditions. At best it is never as exact at matching colors and otherwise measuring light strength as could be desired. Fatigue and other causes will still further decrease the eye's efficiency. A matched pair of photo-electric cells registers the light intensities accurately and without variation. The photo-electric cell is extremely sensitive to change in light intensity and it is not affected by long usage.—*Electronics, January, 1933.*



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Volume indicator

A new line of volume indicators for the broadcast field is announced by The Daven Company, Newark, N. J. The instruments are of the copper oxide rectifier type and are furnished mounted in a box for laboratory use or on standard rack panel. The multiplying network is of the L type and is made with a constant impedance of 5,000 ohms. Standard units are furnished with 2 db. per step.

Daven volume indicators are obtainable in two sensitivities. The standard unit, most suitable for ordinary purposes, has a range from —10 db. to +46 db. Besides this there is also a special meter having a range from —20 db. to +36 db. The first one has a sturdy movement which will stand much abuse, while the second type is extremely sensitive and should only be used where such sensitivity is expressly required.—*Electronics, January, 1933.*

◆

Solder in improved package

The Federated Metals Corporation, 75 Folsom St., San Francisco, Calif., is now manufacturing rosin-core and acid-core solders in its exclusive "neatpak" can.

The Neatpak can has a hole in the top. This hole is covered with cellophane, preventing dust or dirt getting to the solder while in storage.

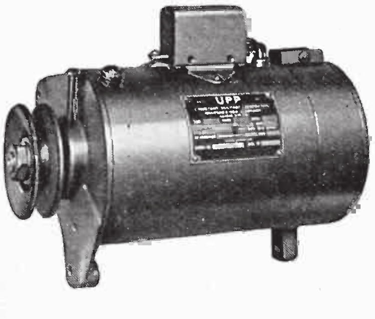
When the solder is to be used, the cellophane is broken and as much solder as required pulled out. This prevents tangling, and also waste, inasmuch as only as much solder as required is pulled through the hole.

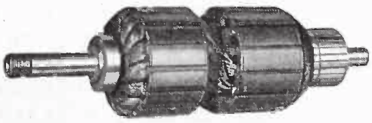
Neatpak acid-core and rosin-core solders are packed in one and five-pound cans.—*Electronics, January, 1933.*

◆

AC-DC generator

Ability to produce constant voltage at variable speeds is one of the outstanding features of the Upp combination D.C.-A.C. generator, for automobile radio and sound equipment operation, now being manufactured by the Whitaker-Upp Company, Kansas City, Mo. This generator is mounted under the hood, is driven by the car engine, and produces both 6 volts D.C. and 110 volts A.C.

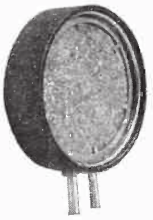




A 60-watt model for auto radio and a 200-watt model for portable sound equipment are now in production, after two years of development and testing. —*Electronics, January, 1933.*

Self-generating photocell

Thomas Rhamstine, manufacturer of precision electrical apparatus, 508 East Woodbridge St., Detroit, Mich., has developed a new self-generating type of photoelectric cell or "electronic" cell, as it is named, of the dry-disk type which transforms light energy directly into electrical energy, without the aid of batteries or any other source of emf. Tested on a direct-current milliameter, the cell generated from 5 to 7 milliamperes in direct sunlight.



This self-generated current is always directly proportional to the light intensity.

Exposure to strong light or any climatic condition has no effect on the cell's efficiency, and it generates electrical energy at no expense to the materials used in its construction. It is of apparently unlimited life. Durably constructed of metal, except for the plain lens over the face of the cell, with reasonable care it should last indefinitely.

In combination with a sensitive relay and an auxiliary relay power circuits can be turned on or off. In addition to all the known commercial and industrial applications, which become more numerous every day, the Rhamstine Electronic cell is an ideal unit for the experimenter and the student.

The cell measures $2\frac{3}{8}$ in. diameter and 1 in. thick. It is equipped with two connection prongs which fit the standard UX radio tube socket. — *Electronics, January, 1933.*

◆

Relay

A new line of relays developed by the Westinghouse Electric & Manufacturing Company, 95 Orange St., Newark, N. J., is especially applicable to circuits. The slow movement of a telephone-type relay armature when carrying an appreciable current often results in severely burned contacts. But on the new relay a "hold-in" contact is provided which keeps the auxiliary relay coil circuit closed, even though the controlling relay may chatter or make intermittent contact.

The non-inductive contact rating is 15 amperes, 120 volts, a.c. or d.c. The coil circuit is regularly supplied for 115 volts, 60 cycles. The coil current is approximately 150 milliamperes when the relay armature is open, and half that value when closed. List price, $7.50.—*Electronics, January, 1933.*

◆

Amplifiers and laboratory equipment

Kendall Clough and Ralph Brengle, formerly chief engineer and general superintendent respectively of Silver-Marshall, Inc., announce the formation of The Clough-Brengle Company with headquarters at 1134 West Austin Ave., Chicago. Associated with them are Ralph P. Glover, who was sound engineer at the former company, and Leon Worner, recently inspection engineer for the same concern. The newly formed company will manufacture laboratory and production test equipment, amplifiers and accessories for sound, broadcast and recording applications, radio specialties and a complete line of audio amplifier and speech-input transformers. In addition to manufacturing, the firm will also engage in consulting engineering on radio receiver and special equipment designs, and on plant layout, cost and production problems.—*Electronics, January, 1933.*

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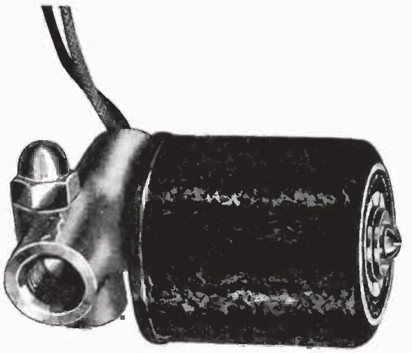
Electrically-operated valves

The Detroit Lubricator Company, Trumbull, Lincoln, Marquette and Viaduct, Detroit, Mich., manufactures a complete line of electric solenoid-operated valves for water and other fluids, which are adapted for control through photo-cells and other electronic devices. The coils of the solenoids are impregnated to resist moisture, tested to 1,500 volts, and will carry rated current indefinitely. Coils may be changed without removing valve from the pipe-line. The plungers are of non-corrosive, stainless iron, accurately ground to diameter. Floating design reduces alternating-current noise. The valve needle and valve seat are made of a special alloy, resistant to corrosion, and burnished to a high polish at the seating edge. Detroit electric valves are supplied to control water, oil, gas, low-pressure steam, refrigerants, etc.—*Electronics, January, 1933.*



Moving-coil meters

The Beede Electrical Instrument Company, 48 West Broadway, N. Y. C., is marketing a new line of D'Arsonval moving-coil meters in which improved design of the moving coil assembly permits a greater simplicity of construction than has heretofore been possible in the art. This results in unusual ruggedness, high accuracy and freedom from interference of dust and foreign matter. The meter is balanced in all positions, and the moving system is exceptionally well damped. Accuracy is guaranteed within 2 per cent.

Cost is the other vital factor; and Beede moving coil meters are available at astonishingly low prices. The list prices are very low for this type of instrument and the low cost is further reflected in the liberal dealer discounts. Contrary to the present day trend, where quality is sacrificed to lower costs, Beede meters represent improved quality and design which, in turn, result in lower production costs.

The Beede Electrical Instrument Company, whose factory is at Penacook, N. H., has been continuously in the business of manufacturing meters for 15 years.—*Electronics, January, 1933.*

◆

Selenium cell employing new principle

The Süddeutsche Apparatefabrik, Nürnburg, Germany, claims for its new selenium cell higher sensitivity than that of alkali-metal cells and relatively low cost. The new cell consists of a layer of selenium fused on an iron disc. Over the selenium there is deposited, by means of a cathode spray, an extremely thin layer of one of the precious metals—so thin as to be transparent. Near its edge this layer is in contact with a somewhat thicker ring-shaped layer of the metal. Terminals are connected to this ring and to the iron base. Incident light causes air emission of electrons at the contact surface of the selenium, and therefore a flow of current through the external circuit.

With a cell of 10 sq.cm. (1.55 sq.in.) surface the current due to a 25-watt lamp at 1 meter (3.3 ft.) distance is 5.1 micro-amperes. It rises to 17.1 micro-amperes with a 75-watt lamp, 76.8 with a 200-watt and 445.5 with a 500-watt projector lamp. This appreciable current output permits direct use of the cell for actuating relays, or reduces the number of stages of amplification. The cell is stated to be rapid enough for voice-films, though it has the drawback that the relation between current and incident light is not quite linear. — *Electronics, January, 1933.*

◆

Electrostatic voltmeters

Ferranti, Inc., 130 W. 42d St., New York City, has introduced a complete line of electrostatic voltmeters, designed to provide a ready measurement of high d.c. and a.c. voltages, particularly in circuits of high resistance where any appreciable current taken by a voltmeter introduces considerable error.

The instruments are entirely free from wave-form, frequency, and temperature errors and are available in the single range projecting, flush or portable types, fitted in moulded bakelite cases.

Meters can be supplied in nine different ranges having full scales from 450 volts to 3,500 volts, the capacity ranging from 30 micro-microfarads with full scale deflection for the 450-volt meter, to 5 micro-microfarads for the 3,500-volt instrument.—*Electronics, January, 1933.*

◆

Motion-picture projectors

The Victor Animatograph Corporation, Davenport, Iowa, is featuring a new line of projectors consisting of three improved models. Taking the place of the previous Models 3 and 7 is the new Model 10 Regular, which is priced at $143.50 against the old price of $175. The Model 10 Regular is supplied with the 400-watt lamp, but may also be used with 200 and 300-watt lamps if desired. All of the exclusive Victor features, such as four-point film protection with automatic film trip, the adjustable shuttle, and the built-in automatic three-way rewind, have been retained in the new models. The instrument is more quiet and smooth running than its predecessor.

The Premier "Hi-Power" 10FH is the feature model of the new Victor line. The powerful 400-watt biplane filament lamp is supplied as standard on this equipment, but 200, 300, and 400-watt lamps of line voltage ratings may also be used.

Other interesting new features of the Premier model are a new rack-and-pinion tilting device, and an automatic pilot which turns on when the projection lamp is extinguished by a turn of the resistance control knob.—*Electronics, January, 1933.*

High-voltage electrostatic generator

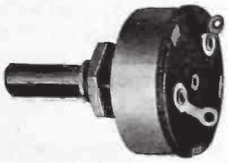
SOMETHING REALLY "new under the sun" in laboratory apparatus is the Cenco-Browne high-voltage electrostatic generator built by the Central Scientific Company, 460 E. Ohio St., Chicago. By means of two belts of special material travelling in opposite directions voltages of from 750,000 to 1,000,000 are developed, resulting in sparks of 30 inches length. This new, high voltage, electrostatic generator was developed from the designs of Ralph C. Browne, Fellow A.I.E.F. It generates under practically all conditions of temperature and humidity. Voltages estimated to be in the range of 500,000 to 750,000 are obtained unfailingly.

The machine consists of two highly insulated collecting spheres, about 15 in. in diameter and about 5½ ft. between centers, into which the charges are carried by two flexible insulating belts.—*Electronics, January, 1933.*

✦

Rotary snap switch

THE WIRT COMPANY, 5221 Greene street, Germantown, Philadelphia, Pa., has put on the market its new 711 single-pole single-throw rotary snap switch. Severe tests have shown this switch to operate with smooth positive action and excellent contact with lowest contact resistance. Simplicity of working parts and ease of mounting make this switch especially applicable for radio-receiver assembly. The switch is rated to carry three amperes at 125 volts.—*Electronics, January, 1933.*



✦

Glass for sodium-vapor lamps

AS A NEW LIGHT SOURCE, sodium vapor has an efficiency of 70 per cent, which is three to four times neon and about six times as much as tungsten filament lighting. The light of the element sodium falls very nearly in that part of the visible spectrum which is most sensitive to the eye, therefore, 70 per cent of the electrical energy passed through the vaporized sodium is converted into light.

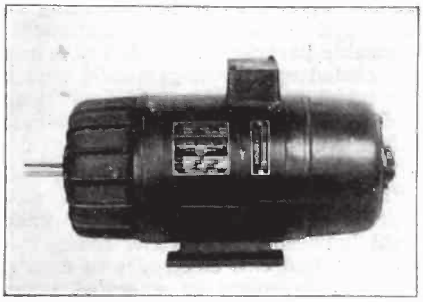
The difficulty in commercializing and adapting such a lamp has been the inability of ordinary glass to resist the attack of sodium. The Jena Glass Works of Schott and Gen., in answer to a universal demand, has now perfected a glass which resists the attack of sodium in their type T-3872. In addition to resisting the attack of sodium it was also important that the glass safely withstands temperatures up to 300°C, at which point sodium vaporizes. It was also necessary that the glasses be made to seal directly with a standard metal for the making of electrodes.

This glass is now being imported into the United States by the Fish-Schurman Corporation, 230 East 45th St., New York City.—*Electronics, January, 1933.*

✦

Constant-speed generator

THE ELECTRIC SPECIALTY COMPANY, Stamford, Conn., has developed this constant output voltage and a.c. frequency when driven from a varying speed source. This machine will operate at constant speed, and when furnished as a self-excited a.c. generator, will deliver constant output voltage and frequency, when driven from a source of power, the sped of which is varying. It is particularly applicable to a.c. generators supplying power to sound amplifiers or talking moving picture equipment mounted on motor trucks. The generator may be driven from the automobile or truck engine, and will then provide a constant and reliable source of power.



The generator consists in a self-excited alternator, with d.c. windings for field excitation, which may also be used for charging the storage battery, if desired, and with a.c. windings delivering 60 cycles, a.c. A special centrifugal clutch has been developed for driving these generators. The working faces of the clutch are covered with a lining which has a constant coefficient of friction throughout a very wide range of activity.—*Electronics, January, 1933.*

✦

"Radio knife" employing induced currents

PAUL C. RAWLS, president of the Technical Equipment Company, Des Moines, Iowa, announces a new form of surgeon's high-frequency knife equipment, in which the cutting current can be carried to the cutting instrument by induction, without wire connection. This "free knife" possibility enables surgeons to operate with no electric-cord connection to the knife, but nevertheless separates tissue by electrical cutting action with a minimum destruction of cellular tissue, while at the same time effecting perfect coagulation of blood vessels. The circuit can also be "tuned" to the conditions of the patient's body and surroundings, giving greater facility of control of the cutting current.—*Electronics, January, 1933.*

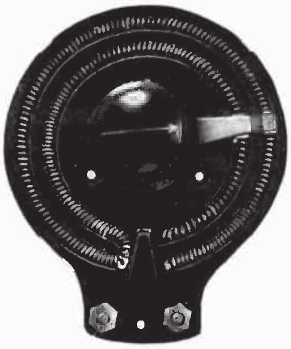
✦

Coil-type rheostat

THE WARD LEONARD ELECTRIC COMPANY, Mount Vernon, N. Y., has produced a new coil-type rheostat for applications requiring a rheostat with a fine continuous adjustment. Its extremely shallow depth is a distinct advantage where space is limited.

The coiled wire resistance element of low-temperature coefficient of resistivity is set in concentric grooves cast in the refractory base. The plate and wire are coated with a powdered glassy enamel, and fired at red heat. This prevents shifting of the resistance wire with the adjustment of the contact shoes.

The dead shaft, completely insulated from the two contact levers, makes the rheostat adaptable for steel panel mounting without the use of insulating bushings or washers.

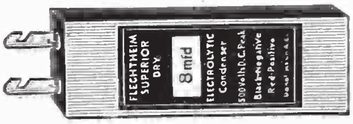


The rheostat is obtainable in values from 1 to 350 ohms. It will dissipate 70 watts continuously with a temperature rise not exceeding 250° C. which is within the limits specified by Underwriters' Laboratories. — *Electronics, January, 1933.*

✦

Dry electrolytic condensers

A. M. FLECHTHEIM & CO., INC., 136 Liberty St., New York City, manufacturers of fixed condensers, announces the addition of a complete line of dry electrolytic condensers rated at 500 volts direct-current peak, in the inverted, upright and cardboard types of containers. The new catalog, No. 25A, lists a wide range of capacities of these condenser units. — *Electronics, January, 1933.*



U. S. PATENTS

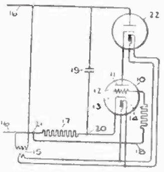
IN THE FIELD OF ELECTRONICS

Electronic Applications

Interference eliminator for electrocardiograph. Method of equalizing or eliminating interfering potential disturbances on the input to an amplifier feeding an electrocardiograph. H. E. Nichols, assigned to Clinical Development Laboratories, Inc. Filed July 16, 1928. No. 1,888,139.

Electron tube control. Method of controlling a three-element gaseous tube. J. D. Le Van assigned to Cutler-Hammer, Inc. Filed October 12, 1929. No. 1,887,766.

Stroboscopic apparatus. Producing instantaneous current impulses synchronous with the frequency of the source to be examined. H. W. Lord assigned to G. E. Co. No. 1,889,608. Filed June 19, 1931.



Electrical cutting apparatus. Method of using a quenched spark gap to drive an oscillating circuit, the voltage of which is utilized for therapeutic purposes. Arthur Mutscheller assigned to Wappler Electric Co. Filed July 21, 1928. No. 1,889,609.

Oscillator for therapeutic purposes. A combination of a vacuum tube circuit and other apparatus for inductively coupling the patient circuit to the oscillatory circuit, and means for varying the constants of the patient circuit whereby it may be brought into resonance with the oscillatory circuit. P. C. Rawles assigned to Technical Equipment Co., Des Moines. Filed Nov. 3, 1930. No. 1,888,408.

Amplification, Generation, Etc.

Magnetron. A slotted anode and cathode with several legs arranged in line with the slots of the anode and means for producing a magnetic field. K. C. De Walt assigned to G. E. Co. Filed Oct. 8, 1929. No. 1,889,595.

Synchronizing system. Several sources of alternating potentials, means for impressing these potentials on a resonant wave coil, and being coupled to the wave coil for indicating the lack of synchronism between frequencies. T. R. Goldsborough assigned to Westinghouse E. & M. Co. Filed April 11, 1929. No. 1,888,721.

Rectifier system. The method of using two arc discharge tubes for rectifying alternating voltages. G. Holst and E. Oosterhuis, Eindhoven, Holland. Assigned to R. C. A. Filed May 18, 1927. No. 1,888,628.

Television, Sound Recording, Photocells, Etc.

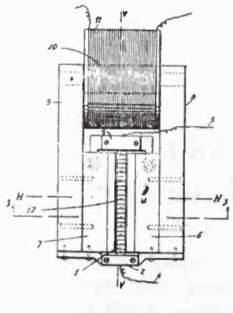
Electric energy converter. Apparatus for converting acoustic energy into electric energy or vice versa comprising a composite magnetostrictive core constituted of mechanically connected members of different magnetostrictive material and a diaphragm connected with the core. G. W. Pierce, Cambridge, Mass. Original filed Aug. 17, 1928. No. 1,889,153.

Recording system. Method of varying the intensity of the field of an electro magnet by impressing audio frequencies upon the circuit controlling the field and transposing magnetically permeable particles suspended in a mixture coated upon a magnetically permeable metal base within said field in accordance with said oscillation. Samuel Ruben, New Rochelle, New York. Filed July 14, 1931. No. 1,889,380.

Photovoltaic cell. Two metal electrodes equally spaced, a wire grid interposed between the two electrodes, said wire grid and two electrodes in contact with an electrolyte in a sealed transparent glass envelope. Samuel Wein assigned to Radiovision Corp. No. 1,887,531. Filed July 31, 1928.

Television system. Rotating mirror type of scanning system. F. Von Okolicsanyi and Gustav Wikkenhauser assigned to Telehor, Berlin, Germany. Filed Sept. 17, 1930. No. 1,887,472.

Velocity microphone. Apparatus for converting sound vibration and electrical vibration comprising a body subjected at opposite sides to pressure variations and a baffle to provide a sound wave path between the opposite sides of the vibrating body equal to half the wavelength of the highest frequency sound waves to be converted into electrical variations. H. F. Olson, assigned to R. C. A. Filed March 31, 1931. No. 1,885,001.



Signal recording. Method of recording electrical energy comprising projecting a stream of marking fluid toward a recording surface and influencing the stream directly by electro-magnetic force to control the amount of fluid reaching the surface. Fritz Schröter assigned to Telefunken. Filed Sept. 12, 1929. No. 1,882,043.

Magnetic sound recording system. Method of magnetically recording sound on a paramagnetic element that comprises first magnetizing the element to a saturated state and then passing the saturated element through a high frequency magnetic shield produced by a sound-modulated high-frequency carrier wave. J. G. Alverson, assigned to Addison-Investment Co., Los Angeles. Filed March 30, 1931. No. 1,886,616.

Sound reproducer. A permanent magnet electrodynamic reproducer and a transformer, the latter mounted upon the permanent magnet at a point of zero potential. P. L. Jensen assigned to the Jensen Radio Mfg. Co. Filed July 25, 1931. No. 1,886,816.

Film sound recording. A photo-phonographic sound recording apparatus. R. E. Grant assigned to R. C. A. Filed Oct. 11, 1930. No. 1,886,540.

Patent Suits

1,448,279, 1,579,392, Pridham & Jensen, Electrodynamic receiver, 1,745,118, same, Sound reproducing device, filed Aug. 15, 1932, D. C., N. D. Calif. (San Francisco). Doc. E 3331-K, The Magnavox Co. v. The Rudolph Wurlitzer Co.

1,258,423, F. Lowenstein, Variable electrical apparatus, C. C. A., 3d Cir., Doc. 4644, M. Balistockey et al. v. Scovill Mfg. Co. Decree reversed Sept. 22, 1932.

Adjudicated Patents

(C. C. A. Del.) Lowell and Dunmore patent, No. 1,455,141, for radio receiving apparatus, claims 3 and 14 Held invalid. Radio Corporation of America v. Dubilier Condenser Corporation. 59 F. (2d) 305.

(C. C. A. Del.) Dunmore patent, No. 1,635,117, for signal-receiving system, claim 9 Held invalid. Radio Corporation of America v. Dubilier Condenser Corporation. 59 F.(2d) 309.

(C. C. A. N. Y.) Colpitts patent, No. 1,128,292, for electric-wave amplifier, claims 1 and 5 Held invalid. Western Electric Co. v. Wallerstein, 60 F.(2d) 723.

(C. C. A. N. Y.) Lowenstein patent, No. 1,231,764, for telephone-relay, claims 1, 2, 4, 5, 6, and 7 Held invalid and, if valid, infringed. Western Electric Co. v. Wallerstein, 60 F.(2d) 723.

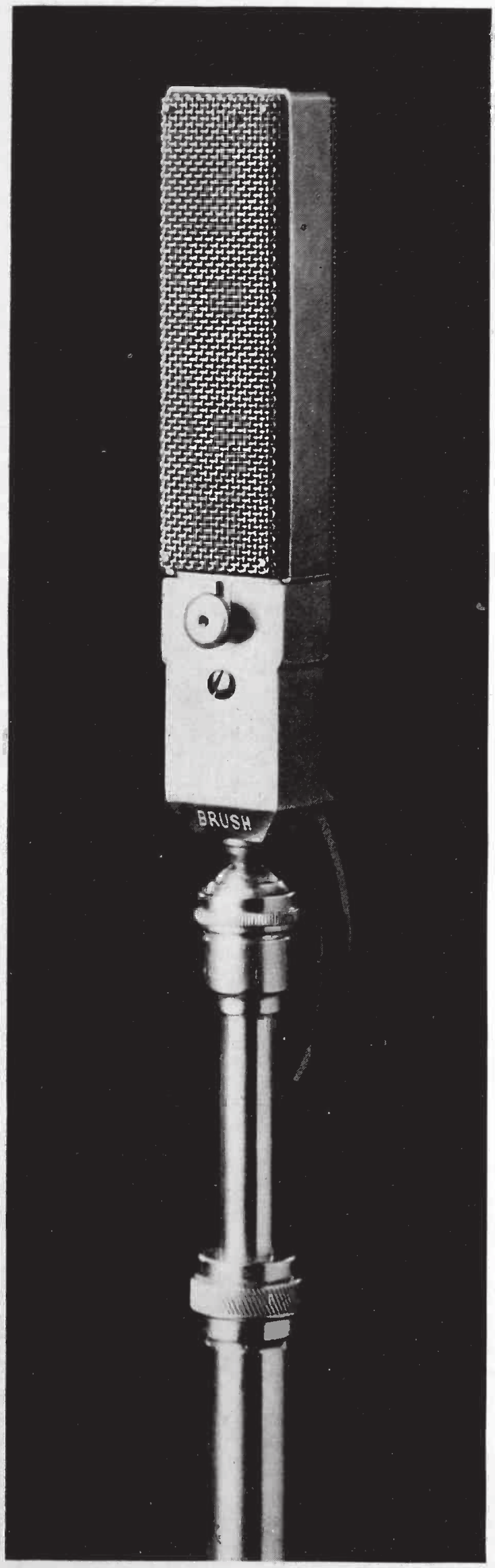
(C. C. A. N. Y.) Mathes patent, No. 1,426,754, for circuits for electron-discharge devices, claim 25 Held invalid. Western Electric Co. v. Wallerstein, 60 F.(2d) 723.

(C. C. A. N. Y.) Blattner patent, No. 1,483,273, for circuit for heating the filaments of audions, claims 6 and 8 Held invalid. Id.

(C. C. A. N. Y.) Arnold patent, No. 1,504,537, for power-limiting amplifying devices, claims 17, 18, 20, 33, 34, 35, and 36 Held invalid. Id.

(D. C. N. Y.) De Forest patent, No. 1,507,016, for radio-signaling system, claims 24, 25, 26, 27 and 28 Held infringed. Radio Corporation of America v. Radio Engineering Laboratories, 1 F. Supp. 65.

(D. C. N. Y.) De Forest patent, No. 1,507,017, for wireless telegraph and telephone system, claims 15, 17, 18, 19, 20, and 21 Held infringed. Id.



BRUSH

ANNOUNCES

a new principle in recording, reproduction and measurement of sound; available in a* COMPLETE LINE *of* MICROPHONES *having the following general characteristics:*

1. **EXTREME RUGGEDNESS.** Having no delicate mechanical parts, the Brush Grille type microphone is almost unbreakable, is unaffected by vibration or shock and cannot be overloaded.
2. **TRANSPARENT TO SOUND.** Being constructed of a number of "sound cells"* arranged edgewise to form a grille, there is a minimum distortion of the wave front, no reflection or pressure doubling and no cavity resonance.
3. **IMPROVED FIDELITY.** No low cut-off. Absolutely flat response over the whole broadcast range. To obviate the necessity of using a compensated amplifier the microphone is designed to have a rising characteristic from 6,000 cycles to 10,000 cycles.
4. **NON-DIRECTIONAL.** Therefore ideal for studio work.
5. **ELECTRICAL AND PHYSICAL CONVENIENCE.** Light and strong. It may be used in any position. High capacity — low impedance. High output level. Only two conductors, no field current or polarizing voltage, therefore free from background noise.

Following types now available:

TYPE G-20 (Illustrated two-thirds full size) is the general purpose studio microphone. It consists of twenty "sound cells"* connected to give the required output — mounted in monel-metal cage and plug. May be unplugged from stand and plugged into overhead suspension in a few seconds.

TYPE G-1 — single 'sound cell' in case 1½" x 1" x ¼" must be within about 30 feet of preamplifier. Ideal where microphone must be concealed in film recording; for announcing, for use in parabola and as "lapel" microphone.

CONDENSER HEAD SUBSTITUTES — May be used to replace present condenser head in amplifier, converting condenser into crystal microphone, doing away with frequent adjustments and greatly improving the response.

**Sound Cells:* Brush Piezo-electric "Sound Cells" are crystal energy-converters whose active surfaces are less than one-half square inch each. This extraordinarily small size results, as already noted above, in absolutely natural response never possible with diaphragm-type microphones. It has the additional advantage that any number may be combined in a single microphone according to the output required.

THE BRUSH DEVELOPMENT COMPANY

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Toronto, Ontario, Canada

●

NEUFELDT & KUHNKE, GMBH
Kiel, Germany

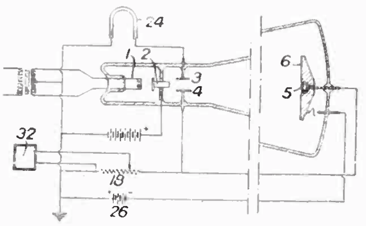
BRITISH PATENTS

IN THE FIELD OF ELECTRONICS

Electron Tubes

Thermionic cathode. A mixture containing alkaline earth carbonate is sintered so as to increase greatly the size of the carbonate particle, for example, from one micron to 120 microns and is then applied to the cathode core. In one example, equal weight of precipitated carbonate and strontium carbonate are mixed, placed in a nickel boat, heated for ten minutes to a temperature of 1,100 deg. C. in a stream of carbon dioxide and cooled while still in the gas. The mass is mixed in a ball mill, heated for 70 minutes, and cooled as before. The mass is then ball milled for five minutes and particles over 120 microns in diameter sifted out and crushed. The mixture may then be suspended in a binding medium, coated on the cathode core and reduced to the oxide in the usual way. W. H. Aldous and J. F. Jackson, G. E. Co. No. 378,651.

Cathode ray tube. An oscillation generator having a double target electrode consisting of the central electrode surrounded by an annular electrode. C. B. Terry Marconi Co. No. 379,812.



Cathode ray tube. The anode of the cathode ray tube is coated with carbon in a finely divided state to form minute points which glow when struck by electrons. The anode is coated by smoking it in a suitable flame, or it may consist of a nickel base which is preferably slightly oxidized and heated to 800 deg. C. in a furnace through which flows a stream of coal gas or of hydrogen saturated with benzine vapor. R. C. Clincker and L. J. Davies, British Thomson-Houston Co. No. 378,397.

Television lamp. A lamp in which light varies rapidly with the discharge current, and applicable to facsimile television, etc. The bulb is filled at 30 mm. pressure with neon containing ⅜ per cent of argon. With a neon filling a nickel or tungsten cathode gives a red light; a magnesium or cold rolled steel cathode a less red light; a cathode of steel containing 17 per cent of tungsten a yellowish light; and a cathode of cerium iron alloy a purple light. With helium, a magnesium cathode gives a white light.

In forming the cathode tungsten powder may be sintered at 1,700 deg. C. to form a porous body or at 3,000 deg. C. to form a dense body. D. M. Moore, British Thomson-Houston Co. No. 377,726.

Variable-mu amplifier. Construction of a tube in which the grid exercises different rates of control at different portions of the electron stream. In such a tube the cut-off occurs at a much higher value of negative grid bias than in other types of tubes, permitting more gradual control of volume without the introduction of a high proportion of distortion. Boonton Research Corp. No. 376,737.

Gaseous tube. A discharge device containing a gas or vapor or a mixture of these in which electrons for the discharge are produced by an auxiliary cathode; the main electrodes consist of a perforated cathode of extended area through which electrons pass, an anode of extended area and a grid, the anode and cathode being closely spaced apart and the discharge being confined by insulation so that no substantial ionization occurs to heat the electrodes when a voltage higher than the ionization voltage is supplied. J. D. Le Van, Raytheon, Inc. No. 376,517.

Cold cathode tube. In a tube filled with gas at low pressure giving glow discharges, insulating granules are placed between the electrodes which absorb heat and extend and subdivide the discharge pass without obstructing current, so that the striking voltage is increased and arc discharges are avoided or can exist for a short time and are then quickly extinguished. The tube may be used as a protective device when excess voltages are led away by the tube or current through the tube operates overload devices. The granules of material may be quartz, glass, stone, clay, etc. S. Ruppel, Frankfort, Germany. No. 377,238.

Electron Tube Circuits

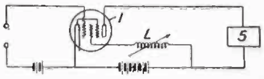
Automatic volume control. In a high frequency receiver having a.v.c., a relay is provided for operating an indicator, when the volume-controlled signal strength reaches a certain level. Marconi Co. No. 374,695.

Temperature control apparatus. Method of using a glow discharge tube as a sensitive element for indicating and controlling the temperature. The tube may contain neon at a pressure of 7 mm. of mercury, helium at a pressure of 14 mm. and mercury vapor from liquid mercury. C. A. Sabbah, assigned to British Thomson-Houston Co. No. 374,754.

Automatic volume control. In a superheterodyne receiver for use as a ship-to-shore telephone receiver, variations in signal strength due to fading and other causes, are eliminated by providing in parallel with the signal detector an additional detector, the output from which is utilized to control the amplification of the receiver in accordance with received intensity. C. G. Kemp and L. G. Kemp, Marconi Co. No. 379,758.

Volume control. In an amplifier the gain is arranged to vary in accordance with signal strength so that loud passages are reproduced at more realistic levels and the change in relative amplitude effected in recording or in wireless transmission is wholly or partially corrected. F. R. Farrow, Marconi Co. No. 379,916.

Frequency correction. To correct the frequency response characteristic of a moving coil loud speaker, associated with a pentode output tube, a reactive impedance coil is connected in the screen-grid circuit of the amplifier. By this means the tendency of the pentode to emphasize the higher frequencies due to its practically constant current output, combined with the increase of loud speaker coil impedance with frequency is obviated. The inductance coil *L* may be variable, constituting a tone control. R. A. Braden, Marconi Co. No. 379,974.



Television system. A two-wave telephone and television system providing a predetermined position for the user, preferably in the form of a chair at a fixed distance from the scanning apparatus. This patent describes rather fully the apparatus in service between the Bell Telephone Laboratories at 463 West Street and the A. T. & T. Co. at 195 Broadway for the past several years. H. E. Ives, assigned to E.R.P.I. No. 375,422.

Automatic volume control. In an audio frequency amplifier means are provided to control automatically the amplification and the ratio between the high and low frequencies in accordance with the input. Walter V. B. Roberts, Marconi Co. No. 378,539.

Inter-stage system. A coupling system operating over a two-wave band with equal efficiency over the whole of each band. H. A. Wheeler, assigned to Hazeltine. No. 378,662.

FIG. 1.

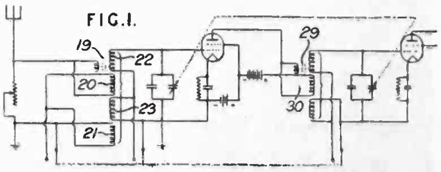
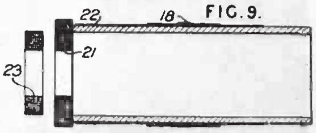


FIG. 9.



High frequency oscillator. Electrons passing from a cathode to an anode are deflected so that they follow alternate paths longer than the shortest distance between two electrodes, the electrons impinging on the anode without overshooting it and generating oscillation in it at its natural frequency. G. L. Usselman, Marconi Co. No. 379,395.

Noise suppression system. In a receiver the detector is arranged to be normally inoperative and to be rendered operative by means actuated by the strength of the incoming signals so that the detector does not function when the signals are below a predetermined value. G. L. Beers, Marconi Co. No. 379,608.

electronics

radio, sound, communications and industrial applications of electron tubes ◆ ◆ ◆ design, engineering, manufacture

Radio City—"Cathedral of Electronics"

◆

Relays for electron-tube circuits

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Thyratron controlled rectifiers

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Data on the new radio tubes

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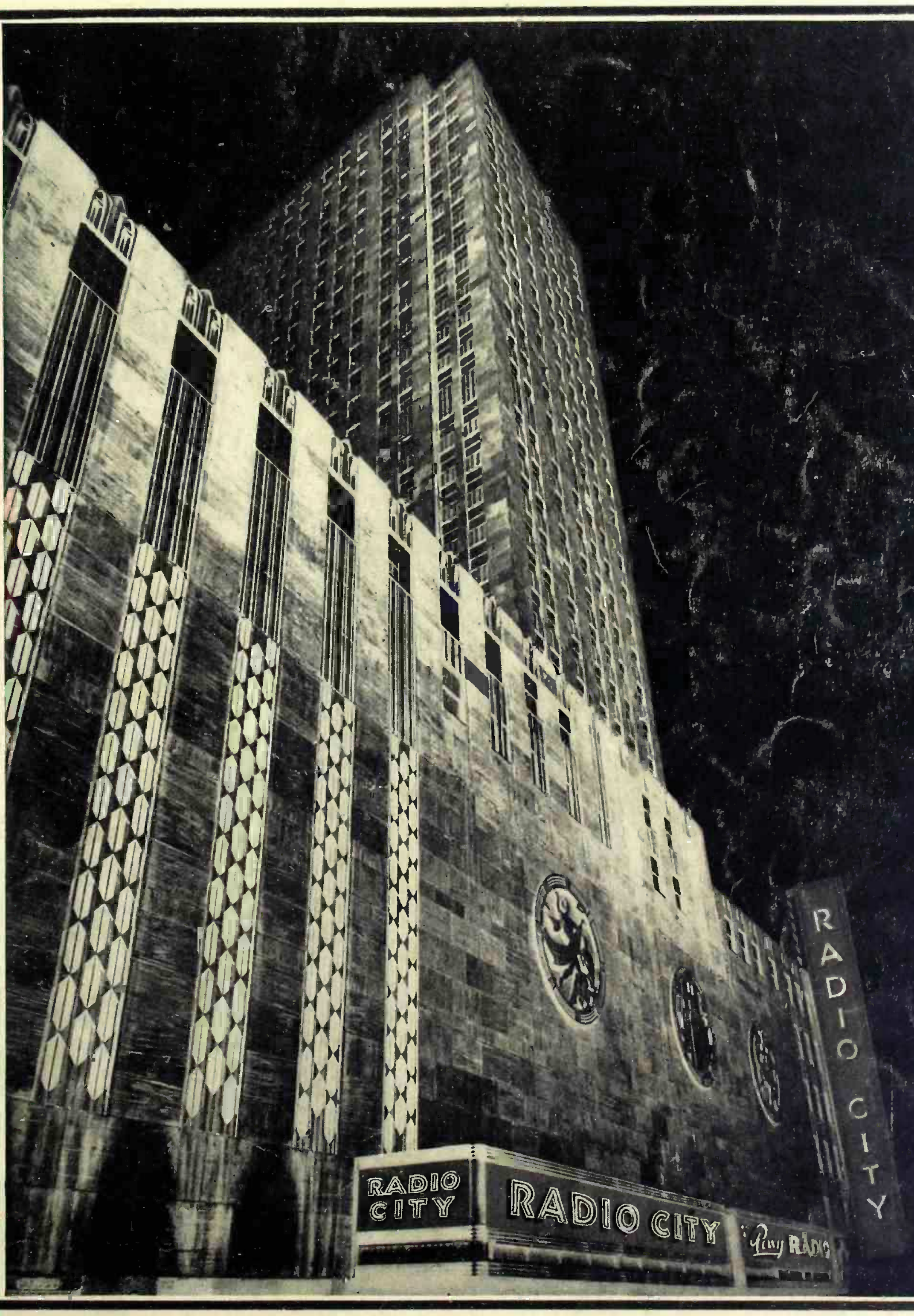
A combined tuning indicator and "noise gate"



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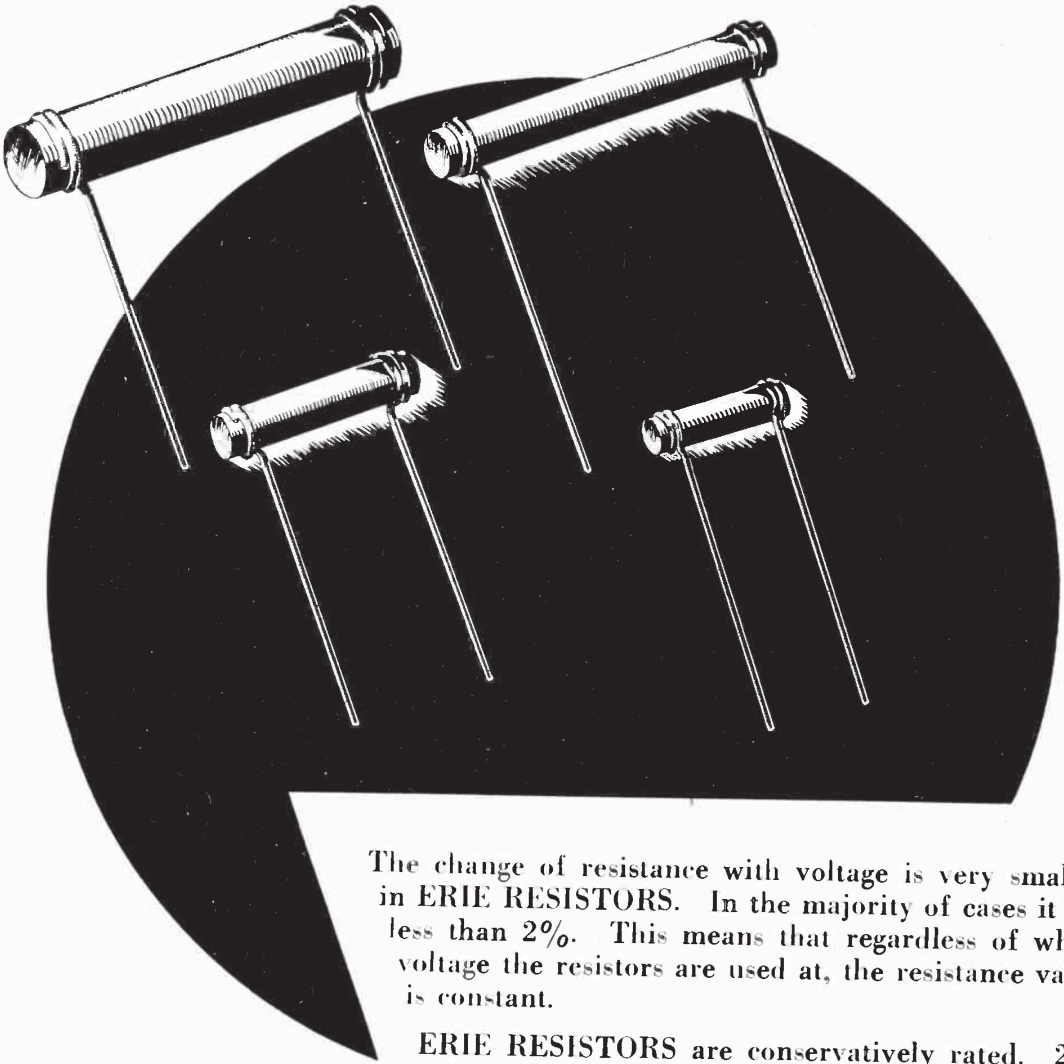
FEBRUARY, 1933



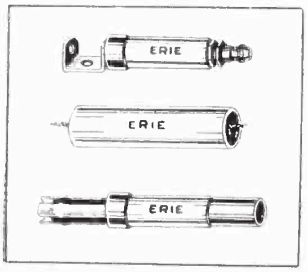
The change of resistance with voltage is very small in ERIE RESISTORS. In the majority of cases it is less than 2%. This means that regardless of what voltage the resistors are used at, the resistance value is constant.

ERIE RESISTORS are conservatively rated. 2,000 hours or more at loads 50% over the continuous rating have shown no failures, in repeated tests.

When you specify ERIE RESISTORS you are getting the very best moulded type resistor of fixed resistance value that the market affords.

Charts showing the small voltage effect and conservative rating of ERIE RESISTORS give the complete story and show the appreciable savings which set manufacturers may make by using them.

We will gladly send you our book of data sheets showing these and other charts which fully explain the technical data on Erie Resistor Corporation High Resistance Products.



ERIE SUPPRESSOR RESISTORS are made in plug, screw and distributor types. They will not change more than 10% in resistance value in 50,000 miles use provided one suppressor resistor is used in each high tension lead.

Samples and additional information gladly given on request.

ERIE RESISTORS

ERIE RESISTOR CORPORATION, ERIE, PA.
Factories in Erie, Pa., Toronto Can., and London, Eng.

Electronics, February, 1933. Vol. 6, No. 2 Published monthly. McGraw-Hill Publishing Company, Inc., 330 West 42d Street, New York, N. Y. $3.00 per year, 35 cents a copy. Foreign Postage, $4 U. S. Currency or 20 shillings. Canada (including Canadian duty), $3.50. Entered as second-class matter April 4, 1930, at the Post Office at New York, N. Y., under the Act of March 3, 1879.

electronics

O. H. CALDWELL
Editor
KEITH HENNEY
Associate Editor

McGRAW-HILL PUBLISHING COMPANY, INC.

New York, February, 1933

radio
sound pictures
telephony
broadcasting
telegraphy
counting
grading
carrier systems
beam transmission
photo cells
facsimile
electric recording
amplifiers
phonographs
measurements
receivers
therapeutics
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musical instruments
machine control
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metering
analysis
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beacons
compasses
automatic processing
crime detection
geophysics

▼

Your stake in the coming

BROADCAST RE-ALLOCATION

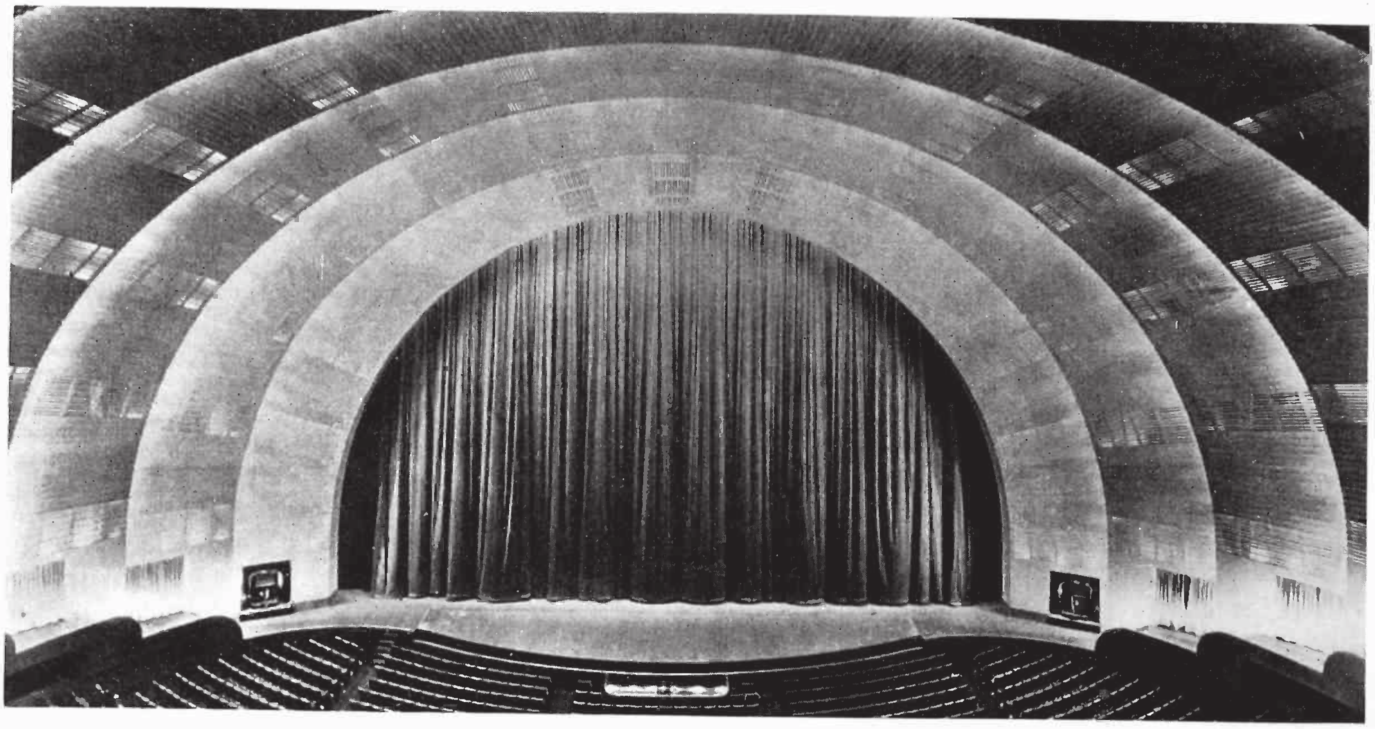
SHORTLY after the new Administration takes hold and the personnel of the Radio Commission is completed, a re-allocation of North American broadcasting stations may be looked for. Pressure from Canada and Mexico for more wavelengths (however unjustified by proportional population figures) will undoubtedly be met by conceding more channels to our northern and southern neighbors. In this re-arrangement, the doom of the U. S. "clear channels," which bring good radio broadcasting to millions in small towns and rural communities, now seems sealed.

WHEN this massacre of the clear channels begins, and the airways on which important broadcasters operate become howling bedlams outside of the immediate neighborhood of the transmitters, the radio industry will have only itself to blame for past apathy. Little or no interest has been displayed by radio engineers or industry organizations. Radio reception in the vast stretches of America, has been taken for granted, like the sunshine. Meanwhile selfish interests and political trading are ever forcing unimportant stations into more advantageous position locally, to the destruction of nationwide good service. At Washington the pressure of those who would ruin outlying reception is continuous; yet never a word comes in rebuttal from radio men who know the inevitable result.

SOON, those who avow to discredit the radio engineer and his "fool theories", will ride high in the political chariots of officialdom. Ignorant, political tampering with the present fairly smooth-running radio machine, will deprive millions in rural communities of good radio. And it will destroy future markets for radio sales. *Gentlemen of the radio industry, wake up!*

ELECTRON TUBES IN

Vast amusement undertaking is veritable "cathedral of electronics"



The Radio City Music Hall, the largest theater in the world, 6100 seats, contains 3000 kw. of lighting controlled by 314 tube-reactor circuits

IT was the electronic tube that made Radio City possible. And Radio City's two great theaters just completed, present the last word in applications of thousands of tubes, for sound, light control and miscellaneous uses. In the electronic installations alone, nearly half a million dollars have gone into tube and associated equipment. Here is the roll call for tube applications now in regular operation.

Thyratron control of stage and auditorium lighting.
Sound-picture reproduction.
Public-address or "re-inforcing" system.
Rehearsal system connecting all operating stations.
Paging throughout dressing rooms and back-stage.
Bechstein-piano amplification.
Radio programs in lobbies.
Outlets for headphones for deaf patrons.
High-frequency air-conditioning.
Dial-controlled radio-phonograph system.
Complete private broadcast studio for Roxy's gang.

Some 3,000 kw. of lighting is controlled over 314 tube-reactor circuits manipulated by the lighting director in the pit box, permitting any change of color or intensity, as well as the presetting of a number of different combinations in advance. Lamp groups in both auditorium and house are divided into four colors, red, amber, green and blue, besides a special daylight color for the stage cyclorama screen. Employing the nearly 2,000 knobs in the control pit, the lighting director and his assistant can preset four to ten scenes in advance, permitting at least ten lighting changes without resetting.

Control of the light intensity in each of the 314 16-kilovolt-ampere circuits is accomplished by passing the voltage supply through one winding of a saturable core reactor functioning as a choke coil. The other winding of this reactor is fed by direct current from a Thyratron and a Phanotron tube. The variation in the direct current by saturating the core, affects the impedance or choking effect on the first or current-supply circuit. In turn the amount of rectified current fed to the second coil will depend on the electrical relationship between the elements of each tube. Changes can be made absolutely gradually, without any individual steps, from "black-out" to full brilliancy. The tube racks are located under the stage, in the basement, and flank the reactors, which are mounted on rubber-insulation supports in a sound-proofed room. Failure of a tube from any cause, results only in the corresponding circuit lamps being extinguished.

The 314 tube-reactor circuits in the 6,100-seat Radio City Music Hall make this by far the most elaborate theater lighting-control scheme ever attempted, with more than twice the number of circuits in the Chicago Civic Opera installation.

RADIO CITY THEATERS

Lighting-control, sound, and air-conditioning applications of tubes

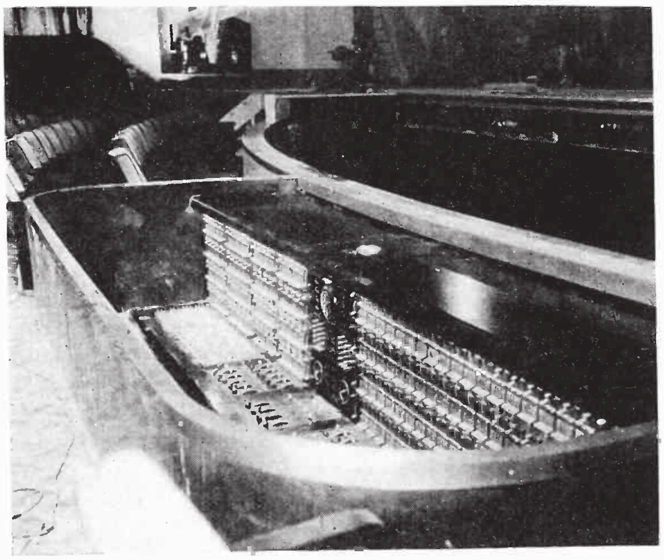
Selsyn operation of the color screens on the 150 spotlights located throughout the auditorium is another innovation in this theater. Small motors drive the selsyn-motors at any of five speeds, and the individual color screens move in exact synchronism through their various changes.

The light control installation in the large Music Hall employs Thyratrons and was made by the General Electric Company. The control equipment in the smaller 3,500-seat Roxy Theater employs a similar tube-reactor system, and was installed by the Hub Electric Company, Chicago. The smaller house employs 190 control circuits, centering in a control board 12 ft. long and 6 ft. high.

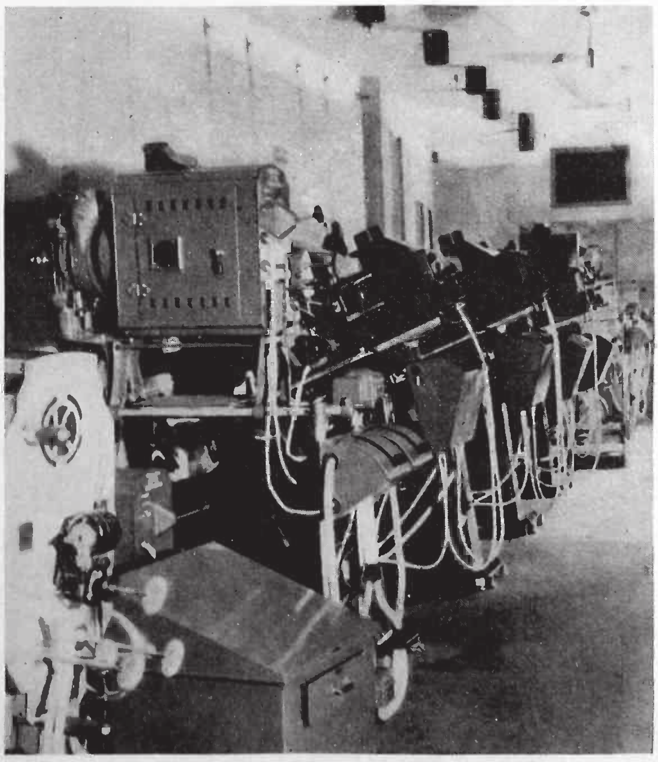
Sound systems in Music Hall

In addition to the four-motion picture projectors which have their own channels, and speakers behinds the screen capable of delivering 10 acoustic watts the elaborate system of sound reproducing equipment installed in Radio City Music Hall by the RCA Victor Company is divided into eight units and covers the widest range of sound apparatus ever used anywhere.

First in importance is the sound reinforcing system which reinforces the stage presentations and orchestra music to suitable levels so that the desired volume and clarity of dialogue and music may be obtained at all points in the auditorium. Fifty plug-in positions for velocity ribbon microphones located at various points near the stage are used in this system. Eleven of these microphones are spotted along the footlights, and are switched in to pick up voices, as the actors move back and forth on the stage. The velocity microphone used it is declared has two and one-half times more sensitivity than a microphone of any other type, and imparts a naturalness of tone and a distinctness of speech hitherto unattainable, according to Ernest Braun, engineer.



The lighting-control box in the pit of the large theater, with its 2000 control knobs

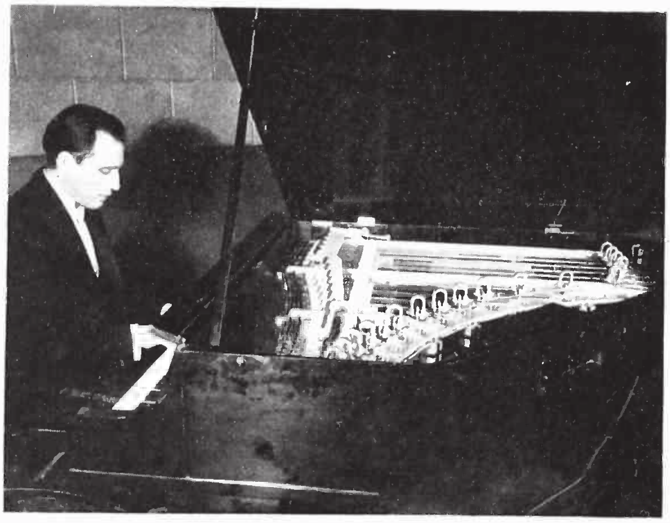


Four sound-picture projectors, with a throw of 180 ft., onto the largest screen ever used

Fifty microphone amplifiers located on a specially constructed rack beneath the stage and operated by a control console apply the desired sound to the loud speakers. All amplifier units are complete in themselves in that they contain their own a.c. operated power apparatus. The sound-control booth is located in the topmost projection gallery, and provides mixing channels for all sound circuits.

Second in the eight-unit system of sound reproducing apparatus is the rehearsal address system. This consists of microphones located at 38 designated points in the auditorium and loudspeakers above the stage. This system was installed for use in connection with the direction and execution of rehearsals and orchestra presentations. Seated at a microphone plugged into one of the outlets in the auditorium the director can convey his instructions to the stage projection room, spotlight rooms, fly gallery or any other part of the theater without raising his voice.

The third unit of sound reproducing apparatus is the stage manager's call system which penetrates practically every part of the theater. Sitting at his desk, the stage



One of the nine Bechstein electronic pianos, with tube amplifiers, imported from Germany

manager can place himself in immediate touch with one or all dressing rooms, stage employes' quarters, the front of the house or the executive offices. Fifty-six loudspeakers are employed in this system.

Another unit of unusual interest is the group of 52 acousticon seat phones for the hard-of-hearing patrons located in the orchestra. Jacks are provided at the seats, and instruments are leased from the checkrooms.

A rear-stage sound projection system is available for the projection of sound-motion pictures from the rear of the stage to be used as background and other effects in conjunction with the stage presentations. It consists essentially of two soundhead attachments, a voltage amplifier unit, a film phonograph with associated amplifier and monitor loudspeaker, all located in the rear stage projection room. When in operation, it is used in conjunction with the main sound projection system.

Two preview rooms, located on the studio floor, are equipped with sound projection systems. These systems are similar in general design to those furnished with the main sound projection system, except that they have a smaller power output. They are of the same high fidelity characteristic as those supplied for the theater auditorium.

A radio and monitoring system furnishes to the private studios on the studio floor, radio pick-up of a predetermined number of radio stations and permit the monitoring of the various sound systems in the theater and other outside lines terminating within the theater. The equipment is completely controlled by a remote-dial system.

For the Roxy Theater, the sound equipment is similar, although less extensive and comprising fewer units in view of the smaller number of seats to be served.

Air-conditioning by ionization

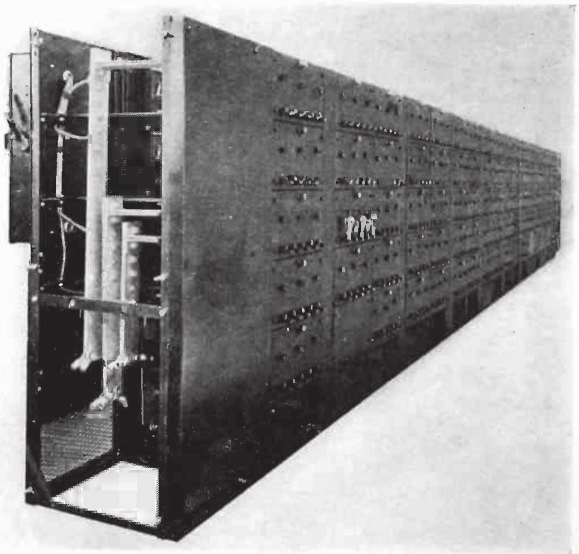
The ventilating system of the Roxy Theater in Radio City is distinguished by an innovation consisting of six ionization machines which provide the equivalent of mountain air in purity and vitality.

This mechanism is the result of approximately twenty years of experimentation seeking a physical and controllable reproduction of nature's methods of air purification. This ionization machine, it is believed is successful in reproducing the natural climatic elements as they exist in open country under ideal weather conditions. A period of two hours in this atmosphere has an essentially invigorating effect, it is declared.

The machine consists of a series of special discharge tubes made of transparent vitreous material, containing an innner and outer electrode. These tubes are energized with a high potential electric current, supplied from a step-up transformer. Within these tubes a luminous discharge, rich in ultra-violet, is set up, while outside of the tube an intense electric field is produced and a non-luminous electric discharge takes place in the air surrounding the tube. Solarization, with ultra-violet light, of somewhat shorter wave length than is normally present in sunlight at the earth's surface, is accomplished by both the discharges within and without the tube.

Nine of the popular Bechstein-Hammond electric pianos were purchased in Germany last summer by Mr. Rothafel, director of Radio City, and several are now installed in the music halls. These pianos are bereft of sounding boards, but have a series of microphones, each of which picks up the vibrations of half-a-dozen piano strings, the output of these microphones then being amplified and heard through loudspeakers. American-built speakers and tubes have been incorporated in these original all-European instruments, with consequent improvement in quality.

The elevators in the office buildings of Radio City are being equipped with photocell safety rays, employing photoelectric units to insure that the elevator doors are clear, before being closed. A projector sends a beam of light across the doorway, shining onto a photocell. If the body of a passenger intercepts this light beam, eclipsing the photocell, relays are operated and the door is prevented from closing, which in turn prevents the elevator from moving. Altogether 58 elevators in Radio City will be so equipped.



One of the long panels for Thyratron control circuits in Music Hall. Reactors are directly behind tubes

The National Broadcasting Company will occupy elaborate studios in Radio City, in the 70-story RCA building. These studios are now under construction. Delays have occurred in the production schedule, and it is now believed that the new Radio City NBC studios will not be ready for originating network programs until sometime in September of this year.

New amplifiers—detectors and rectifiers

NEARLY a score of new tubes was formally introduced to the industry during the first few weeks of the new year. Many of these tubes offered distinct possibilities to receiver engineers with imagination, others pushed forward the frontier (at present somewhat restricted) of high quality reception, and still others seem merely to complicate an already complex picture.

There are new amplifiers, new detectors, new oscillators, new rectifiers. There are new hybrids, combinations of triodes, or diodes, and pentodes in the same envelope. There are complete class B amplifiers under one glass top; there are high-vacuum rectifiers with gaseous rectifier characteristics; tubes for auto radio, for high quality receivers, and tubes for universal a-c, d-c sets, at present all the rage.

Rumors in the industry indicate that interests formerly opposed to unlimited introduction of new tube types have retreated from this conservative stand and are now ready to get in on the fun. All of this will require tube manufacturers to change their plant layout to accommodate a vast number of tube types, and in the process to be willing to take their losses inevitable with changing machines from one type to another.

Among the tubes designed primarily for amplification the 2A3 is most interesting. This is a triode designed purely and simply for those few receivers, now in the laboratory, which will be purchased by people desiring the acme of fidelity of reception. This tube is a power amplifier; it has a very high value of transconductance (5,500 micromhos), and a very low value of resistance (less than 1,000 ohms). The tube has a multifilamentary cathode, many strands of emitter in series and parallel. A single tube will put out 3.5 watts, push-pull tubes will deliver 15 watts.

For those manufacturers who want to use a pentode with the 59-type characteristics, without paying for the versatility of this tube there will be the 2A5, a heater-type power pentode. This tube will probably supercede the 47 because of its low hum output.

The 53, a complete class B tube in one envelope, resembles the 79 except that it has a 2.5-volt cathode and will probably deliver more power output by virtue of its higher plate voltage and greater emission. It is aimed at the low price, small space (and poor bass) receiver.

Among the hybrid tubes there are diode-pentodes and the possibility of a pentode-triode. These are for first and second detectors which frequently have additional functions such as oscillator, or QAVC or first a.f. The 90 and 92 are two-grid detectors, the 2B7 and the 6B7 are duplex diode-pentodes primarily for the second detector although they can be used as first detector or even as the final i-f tube. In the second detector position the pentode may provide audio amplification or noise suppression control.

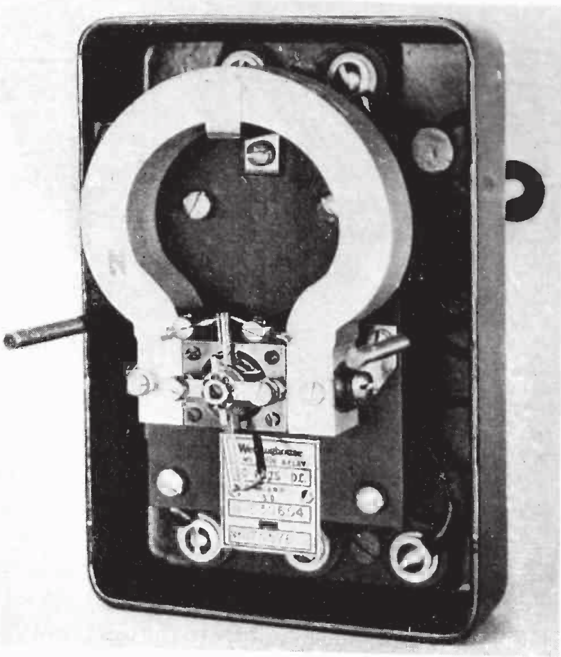
To go with the new power output triode there is a high-vacuum heavy-duty full-wave rectifier delivering 250 ma. For automobile receivers the 84 is of interest as having a very low internal voltage drop despite the fact that it is a high-vacuum tube. The voltage drop is approximately 20 volts obtained by close spacing, and

[*Please turn to page 55*]

				Cathode		Plate								
Type	Use	Bulb	Type	Voltage	Current	Voltage	Current	Screen voltage	Grid bias	Plate resistance	Mutual conductance	Amp. factor	Power output watts	Load resistance
53	Class B amp.......	ST-14	Heater	2.5	2.0	300	12–70	...	0	......	....	....	10	10,000
75	85 with high-mu triode...........	......	Heater	6.3	0.3	180	.....	...	1.5	......	1,000	80	...	......
77	RF pentode.......	ST-12	Heater	6.3	0.3	250	2.25	100	3	1.5 meg.	1,250	1,500	...	......
78	6.3-volt 58.........	ST-12	Heater	6.3	0.3	250	10.0	125	3	0.65 meg.	1,650	....	...	......
79	Class B amp.......	S-12	Heater	6.3	0.6	180	7.5	...	0	......	....	....	5.0	10,000
90	2-grid detector....	S-12	Heater	2.5	1.0	250	3.5	...	0	10,000	1,400	14	...	100,000
92	2-grid detector....	S-12	Heater	6.3	0.4	250	3.5	...	0	10,000	1,400	14	...	100,000
2A3	Power output triode	ST-16	Filament	2.5	2.5	250	60	...	42	765	5,500	4.2	3.5	2,500
2A5	Power output pentode............	ST-14	Heater	2.5	1.75	250	34	250	16.5	100,000	2,200	220	3.0	7,000
2A7	Electron coupled detector-oscillator	ST-12	Heater	2.5	0.8	250	3.0	E_1 = Self-biased $E_2 = 250$, $I_2 = 10$ $E_3 = +100$ E_4 = 3 to —50 E_6 = tied to No. 3 grid						
2B7	Diode-pentode....	ST-12	Heater	2.5	0.8	250	5.5	100	3	Pentode section				
6A7	Electron coupled detector-oscillator	ST-12	Heater	6.3	0.3	250	3.0	E_1 = Self-biased $E_2 = 250$, $I_2 = 10$ $E_3 = +100$ E_4 = 3 to —42.5 E_6 = tied to No. 3 grid						
6B7	Diode-pentode	ST-12	Heater	6.3	0.3	250	5.5	100	3	Pentode section				

Note: Values given in this table are subject to considerable change as several tubes were still in the development stage at the time the table was compiled.

Relays for electronic devices



Relay of supersensitive type

IN THE wide acclaim for electronic devices, particularly those operating from light-sensitive units, a fundamental and important part of the circuit is frequently forgotten.

This is the relay; the connecting link between the stream of electrons and the work to be accomplished. Many light-sensitive surfaces coming into use today are really very old and the literature contains many references to combinations discovered anew each year. But the sensitive, rugged and comparatively inexpensive relays so important to the art are relatively recent in development. In this survey, the types of relays requiring less than 0.5 ma. will be called supersensitive, those requiring one or more milliamperes are of the telephone type, and the heavy-duty relays with contacts which can carry up to several amperes will be called auxiliary relays. Voltage, current, and resistance will be the d.-c. values, unless marked a.-c.

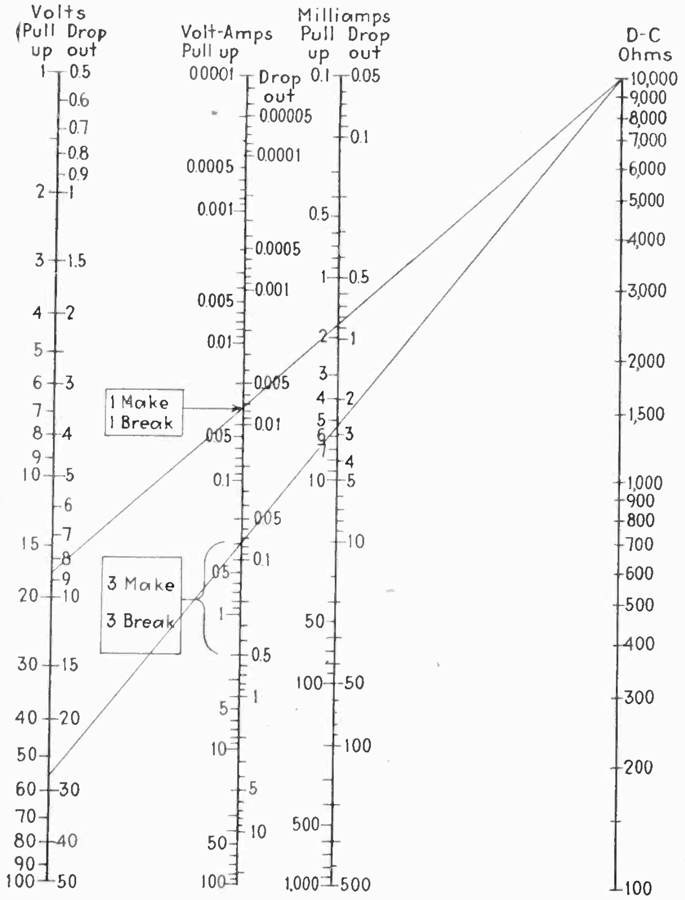


Fig. 1—Nomogram giving essential data on d.c. relays of telephone type. The most sensitive one-make, one-break relay is marked at 0.03; the average sensitivity of more complicated relays is noted. This chart is made on the assumption that the drop-out current or voltage is one half the pick-up, and one-quarter the volt-amperes

Supersensitive relays

Supersensitive relays are made to operate on currents as small as 15μa, have a resistance of 1,000 ohms, and can be made to close circuits from the output of a light-sensitive metallic disc, a vacuum tube or a selenium cell.

The supersensitive relays can be used in three ways:

1. Galvanometer (zero center) relays: with no current flowing, the contact arm rests midway between the contacts. When current flows, the contact arm moves either to the left or right contact, depending on the polarity.
2. Constant current relays: with a definite value of current flowing, the contact arm rests midway between the contacts. When the value of current decreases a predetermined amount, the left (low) contact is closed and when the value of current increases a predetermined amount, the right (high) contact is closed.
3. Low and high current relays: This is an extension of the preceding case. With all values above a predetermined high value, the contact arm rests against the "high" contact. With all values below a predetermined low value, the contact arm rests against the "low" contact. For any value between the low and high values neither contact is closed.

For quick action, such as a light-beam counting instrument, the contact points are set close together, so that the contact arm moves only a short distance. These supersensitive relays are generally used as a single-pole, single- (or double-) throw switch, and are used to control other relays having a heavier current-carrying capacity, or to actuate signal devices. Table *A* shows some stock ratings and current capacities of these relays. By comparing the current capacity of the relays of Table *A*, with the coil requirements of Table *B*, *C* or *D*, arrangements of auxiliary or telephone relays can be made.

Among the relays originally made for telephone work there are now several types especially suited for use in the plate circuits of amplifier tubes. The most sensitive telephone-type relays, operating on one or two milliamperes d.-c., are provided with one make contact, or one break contact, or both, in order to require the minimum of electrical energy for operation. Such relays have as much as 10,000 ohms d.-c. resistance.

Telephone relays of the same general form and size usually pick up with the same speed. The drop-out time can be lengthened by using certain devices to prevent rapid decrease of magnetic flux. For instance, the medium relay speeds are attained by a copper sleeve on the core piece, and the slow relays by a heavy copper slug on the end of the core.

The sensitive relays are of the fast type, and can be made to operate in 0.02 to 0.05 seconds, and drop out in the same time. The less sensitive, lower resistance relays can be made in fast, medium and slow operating speeds. These times are given in Table B.

To operate from plate circuits, it is generally advisable for the relay to have as high a drop-out value as possible. For example, suppose a relay to pull up (close a make contact, or open a break contact) on 2.0 milliamperes d.-c. This means that the relay will pull up when the grid of the tube is supplied with a voltage which allows a plate current of 2.0 ma. to pass. For sensitive operation, the minimum plate current change, with a corresponding small grid voltage change (high transconductance) is needed. Any relay will drop out if the current through it is decreased to zero—but this requires a negative grid voltage sufficient to bias the tube to the cut-off point of plate current. If, however, the above-mentioned relay drops out at 1.0 ma., then the grid swing can be less negative, and a more sensitive circuit is the result. Most of the sensitive telephone-type relays are designed to drop out for values of current of the order of one-half their pull-up currents.

The currents needed to pull up a relay have been mentioned; but this is not the only useful factor. It is necessary to know at least one other item, usually the resistance. Knowing the pull-up and drop-out currents, and the resistance, a good working idea of the sensitivity of the relay can be obtained from calculation, or from Fig. 1 which is a nomogram of the useful quantities concerning the relay coil. The most sensitive relay is one which will pull up with the least volt-amperes (watts), and by suitably matching the resistance to the circuit to be used, maximum sensitivity is attained.

With a given set of relay constants, frame, contacts, and springs, some interesting coil characteristics are given in Fig. 1. Usually the sensitive telephone relays operate on 0.03 to 0.05 volt-amperes. Now if exactly similar relays are desired, with different coil resistances, the volt-amperes will be approximately the same, and the desired currents, voltages, and resistance can be found directly on the chart.

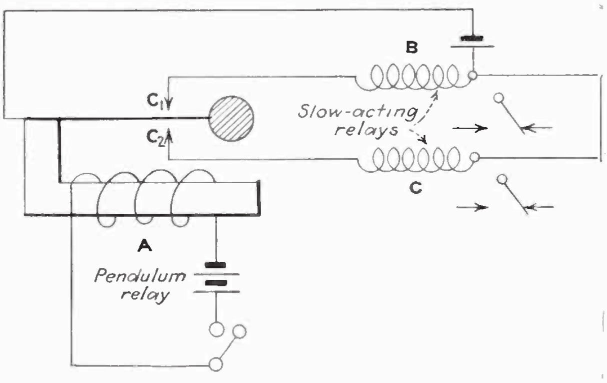


Fig. 2—Pendulum or vibrating reed relay

The values as found on Fig. 1, for different coils, with the same frame, springs, etc., will be approximate for any of the relays given in Table B. They are quite accurate when used for finding coil characteristics of low resistance relays, from similar high-resistance sensitive relay coils. The reason for this is that a high-resistance coil is wound with very fine copper wire, and the wire covering and other insulation is a fairly high percentage of the active cross-section of the wire. Lower resistance coils have a lesser percentage of insulation. This means that the ampere-turns of the lower resistance coil can be increased with the same available winding space. As an example, a 10,000-ohm coil for a sensitive relay requiring 0.05 volt-amperes, can be replaced by a 1,000-ohm coil requiring 0.05 volt-amperes, or slightly less. Using the volt-amperes for the sensitive relay, a lower resistance coil can usually be safely expected to work on the same (or lower) volt-amperes.

Fairly sensitive telephone-type relays can be made with three make and three break circuits[2,3], the equivalent of a 3-pole double-throw switch. More contacts than these can be provided if needed for special purposes. Extra contacts require additional coil energy for operation. Practically all of the relays in Table B can be supplied with the 3 P D T arrangement.

A recent development is the use of high carrying capacity switches, having a mercury[8] or vacuum contact[3,7], actuated by a telephone relay mechanism. This

TABLE A — SUPERSENSITIVE RELAY

Operating Current Microamperes	Resistance Ohms	Contact Rating	Price
15[1]	1,100	Under 0.2 amps. at 6 volts;	$37.75
20[1]	500	or loads which do not pro-	37.75
250[1]	300	duce a visible spark of arc	34.00 (Approx.)
10 to 15[8]	1,100	0.2 amp at 6 v.	40.00
30[8]	1,100	....	25.00

TABLE B — TELEPHONE-TYPE AND SENSITIVE RELAYS

Pick-up current amperes	Release current amperes	Resistance ohms	Volts	Contact	Speed	Designation
0.003[3]	0.0003	3,800	....	SPDT 50 watts non-inductive	0.01 to 0.02 sec. make and 0.01 break	FQA
0.046[3] a.c.	......	130	110 v. 60 cycle	SPDT		FQA
0.004[3]	0.002	3,200	....	SPDT		AQA
0.0005[4]	0.0004	14,000	....	SPDT		TQA micrometer adjusting
Prices vary from $2.50 to $5.00 except for TQA						
0.001[4]	......	10,000	....	SPDT 2 amp. 110 a.c. 2 amp. 12 d.c.	......	CAX-51 Price $5
0.0019[2]*	0.001	9,000	....	SPDT	Release 0.02 sec.	3,700 fast coil, short armature
0.003[2]*	0.0008	8,000	....	SPDT	Release 0.1 sec.	3,000 medium coil, short armature
0.0035[2]*	0.001	5,000	....	SPDT	Release 0.2 sec.	2,600 slow coil, short armature

*Make in 0.005 to 0.015 sec. and can be furnished with double point bronze contacts for light duty. Double point gold contacts will carry 0.1 amp., 50 volts on intermittent service. Single or double platinum contacts for severe service. ⅛ in. silver contacts, 1 amp. 120 volts intermittent, and for low inductive loads. 3/16 in. platinum contacts for inductive loads, and continuous service.

Prices range from $3.70 (bronze contacts) to $5.30 for 3/16 in. platinum contacts.

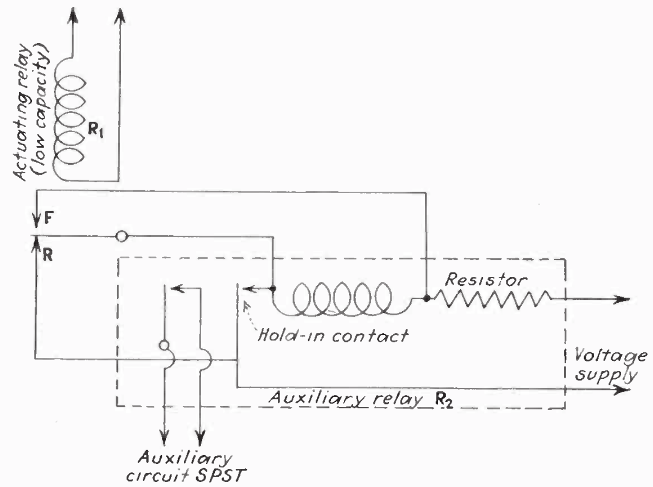


Fig. 3—Auxiliary relay circuit with lock-in feature

makes the control of heavy currents possible by a single plate-circuit relay.

A fairly new group of relays is of the general shape of the telephone relay, but it is designed to use alternating current[3]. These relays are also useful for plate circuits having self-rectification. A shading coil holds in the relay armature during the no-voltage part of the cycle.

Mechanical delay relays are of several types. The vibrating reed[2,8] is used to hold in one or two slow-action relays during the time of vibration, which can be adjusted. Figure 2 shows a typical circuit. By adjusting the contacts, *B* and *C* can be kept closed for time delays from 1 to 10 seconds.

An oil-dashpot relay[3] is also used for time delays; this type of relay does not require a special circuit. The sunflower, or step-by-step relay, is similar to that used in telephone circuits, and can be used to select one of several possible operations. Each pulse of electrical energy moves an arm one position.

Mechanical latch relays are sometimes useful; the relay pulls up and stays up until a release is secured either manually, or by energizing a second operating coil. Polarized relays either make or break a circuit according to the polarity of the impulse supplied. Counters for recording the number of impulses given, are of use in many applications.

It is assumed that the general use of the auxiliary relay is to control fairly heavy currents, from one to ten amperes, from a smaller capacity relay. These relays will, therefore, be operated on commercial voltages and frequencies, usually 115 volts 60 cycles. In some cases, operation from a 6-volt storage battery or a 115-volt d.-c. line is desirable; these are in Table D.

Other contact ratings, and number of poles may be secured through correspondence with the manufacturers. Table D shows only single-pole, single-throw auxiliary relays; both front and back operated, i.e., a make contact when the coil is energized or de-energized respectively.

Circuits which operate slowly, often cause severe burning of the low capacity relay contacts, when operating an auxiliary relay. A recent auxiliary relay[8] has been developed having an arrangement which prevents arcing or burning of the telephone-type relay contacts. The circuit is shown in Fig. 3. When R_1 armature touches the *F* contact, the coil of relay R_2 (in series with resistor) pulls up, and the hold-in contact keeps R_2 closed. Relay R_1 can now vibrate or make intermittent contact, but no sparking takes place because of the closed auxiliary contact.

When the R_1 armature moves back to the rear contact *R*, the R_2 coil is shorted, full voltage being momentarily put on the resistor until the hold-in contact opens.

This relay also prevents destruction of telephone-type relay contacts under severe conditions of chattering, vibration, etc., as the auxiliary relay coil circuit remains closed, once it has been actuated, until the smaller relay definitely opens, and touches its other contact.

TABLE C — SPECIAL PURPOSE RELAYS

Description	Operating time	Volts Amps.	Resistance ohms	Approx. list price
Pendulum relays[2], [3] type 2000[2]................	1 to 10 sec.	6 v. 45 v. 120 v.	7.5 250 2,000	$5.00 ....
Vacuum contact[3], [7]........	....	115 v., 60 cycle	5,200	.....
Magnetic counter[5] 5 figures, with reset. Type US, Type UD for d.c.	0.1 sec. per impulse (0.05 sec. on 0.05 sec. off min.)	115 v., 60 cycle 0.5 amp. 115 v. d. c.	....	25.00 25.00
Magnetic counter[3] 4 figures, no reset...............	....	115v. a.c. 60 cycle 0.1 amp.		
Operation indicator[8] Type C to show circuit operation, manual reset — use in series with relay.	0.1 amp.* 0.15 amp† 1.0 amp.* 1.5 amp.†		6.0 ohm* 0.06 ohm*	$1.50 $1.50

* D.C.. † A.C

TABLE D — AUXILIARY RELAYS

Front or back contact, and designation	Contact Capacity Volts	Contact Capacity Amps.	Coil	List price
Front L[6].............	110 a.c. 115 d.c.	5 4	110 a.c. 60 cycle	$28.00
P[6].............	110 a.c. 115 d.c.	10 6	110 a.c. 60 cycle 110 a.c. 60 cycle	29.00
R[6].............	110 a.c. 115 d.c.	15 10	110 a.c. 60 cycle	30.00
E[6].............	110 a.c. 115 d.c.	20 10	110 a.c. 60 cycle	31.00
Back L[6].............	110 a.c. 115 d.c.	5 3	110 a.c. 60 cycle	26.00
R[6].............	110 a.c. 115 d.c.	15 6	110 a.c. 60 cycle	28.00
Back B[4].............	Non-inductive 110 a.c. 110 d.c. 220 a.c.	 10 2 8	Coil 7 watts 110 a.c. 60 cycle 0.165 amp.	6.00
Front A[4].............	Non-inductive 110 a.c. 110 d.c. 220 a.c.	 30 6 3	Coil 7 watts 110 a.c. 60 cycle 0.165 amp.	6.00
Front A[4]............. Blow-out coils for 5, 10, 15, 20, 25 or 30 amp.	Inductive and d.c. 230 a.c. 230 d.c.	 30 30	Coil 7 watts 110 a.c. 60 cycle 0.165 amp.	8.00
Front[8]................. (double break)	Non-inductive 120 a.c. 120 d.c.	 30 30	115 a.c. 60 cycle 0.15 amp.	6.00
Front[8] single break with auxiliary (hold-in) contact	Non-inductive 120 a.c. 120 d.c.	 15 15	115 v. a.c. 60 cycle 0.25 amp.	7.50

MANUFACTURERS

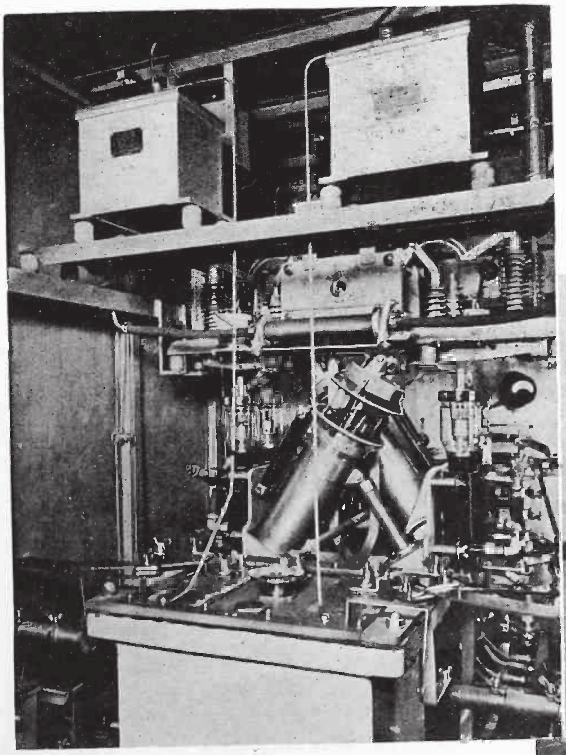
[1] Weston Electric Instrument Company, Newark, N. J.
[2] North Electric Company, Galion, Ohio.
[3] Automatic Electric Company, 1033 W. Van Buren St., Chicago, Ill.
[4] Struthers-Dunn Company, 139 N. Juniper St., Phila., Pa.
[5] Veeder-Root Company, Hartford, Conn.
[6] Signal Engineering & Manufacturing Company, 154 W. 14th St., New York City
[7] C. F. Burgess Laboratories, 202 E. 42nd St., New York City
[8] Westinghouse Electric & Manufacturing Company, 95 Orange St., Newark, N. J.

Note: This is, of course, not a complete list of relay manufacturers, nor is it even a comprehensive list of relays. Hundreds of relays and combinations are for sale by the above manufacturers as well as by Western Electric, Stromberg Carlson, General Electric, Ward Leonard, American Instrument Co. and others.

ELECTRONS IN NEW ROLES

An "automatic dial" selects the wavelength wanted, in this new short-wave set used by the United Air Lines, Chicago. Any one of five or six planes can be reached by dialing its number

In Berlin, Germany, Alfred Mintus has produced this walking-stick radio set. The cane forms its own ground and antenna



The new British Empire Broadcasting station at Daventry, England, is designed to send out short-wave programs to the entire world. It started into operation last month

A visitor to the vault of the East River Savings Bank, Amsterdam Ave., New York City, has his approach announced by an electric-eye, which receives its beam from a mirror opposite

Gaseous discharge tubes for radio receiver use

By JOHN F. DREYER, Jr.

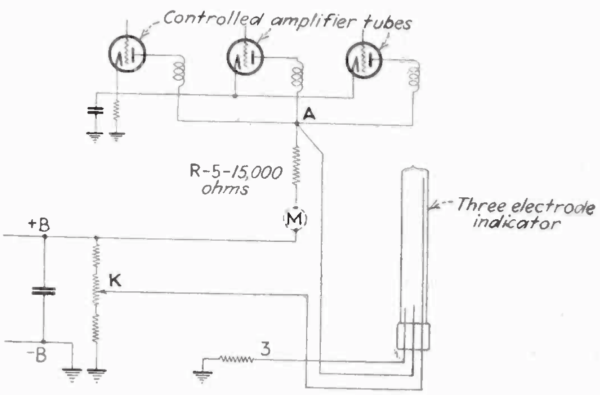


Fig. 2—Essential circuit elements of gaseous discharge tuning indicator

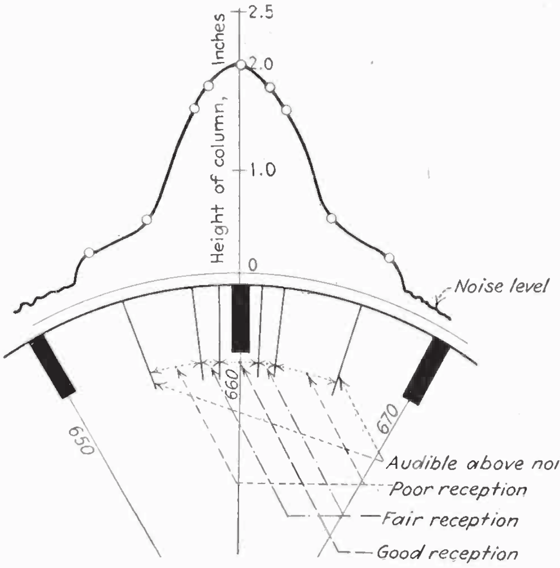


Fig. 3—Action of tuning-indicator on local signal

MODERN radio receivers, generally of the super-heterodyne type, have extremely sharp resonance curves. In general, also, they are equipped with automatic volume control. Receivers of this type, although yielding very satisfactory reception when adjusted exactly to the carrier-frequency of the desired station, prove difficult for the user to adjust.

To illustrate this point an average, moderately priced nine-tube super-heterodyne receiver was examined. The location was uptown New York City and a good but not extreme antenna was used. First, WEAF, 660 kc. was observed. In turning the station selector from 650 kc. to 670 kc. it was observed that over a considerable portion of this range, the station was received with considerable volume and extremely poor quality. Also at times a very objectionable hiss was heard accompanying the signal. Over a very small portion of the range, corresponding to the proper frequency, the station was received with proper tone quality and free from disturbing noises. Also, at 650 and 670 kc., where no receivable signal existed, the receiver brought in at a maximum, all the disturbing noises generated by sparking electrical apparatus in the vicinity.

These undesirable characteristics are typical and occur when adjusting to any other signal. Radio manufacturers, appreciating these things, have modified their circuits to minimize them. The distortions which occur are: High amplification of inter-carrier noises; over-emphasis of higher side-band frequencies when off tune, due to shape of reasonance curve, and due to excess amplification caused by the AVC system. That is, the proper amplification for desired signal is only obtained when the carrier frequency registers with the maximum resonance response. These effects are minimized by the addition of a visual tuning indicator and a silencing device. The silencing device may be manual or automatic. When automatic, the arrangement is sometimes referred to as a "noise gate."

In this receiver, the AVC feature operates to adjust the grid bias of the r.f. amplifier tubes. The gain is made sufficient to amplify the input signal to an approximately constant voltage at the second detector. This results in a low grid bias when the receiver is tuned to a point in the broadcast spectrum where the input is weak. On the other hand, when the input signal at a particular frequency is strong, the grid bias is increased. This results in the plate current of the amplifier tubes varying in a definite manner with signal strength. Figure 1 illustrates this variation of plate current with signal

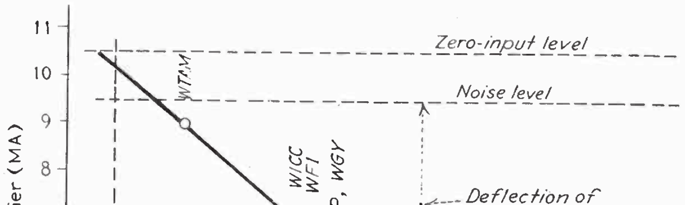


Fig. 1—Plate current variation in nine-tube super-heterodyne. Daytime signals in New York City

input for the particular receiver mentioned. It will be noted that the plate current is recorded for various signals from approximately 10 μv. to 30,000 μv. The curve is a straight line through most of its length, when the scale of signal inputs is plotted exponentially. With antenna and ground shorted (no signal input of any kind) the plate current was approximately 10.5 ma.; with antenna connected and receiver tuned between stations, the plate current was depressed to an average value of 9.5 ma. This was due to a general noise level.

The gaseous discharge tube provided with a long cathode, a short anode and an auxiliary electrode was devised by Professor A. Senauke of New York University, to be applied to AVC receivers to serve as a visual tuning indicator. Figure 2 illustrates the essential portions of the circuit of an AVC receiver for providing visual tuning with the gaseous discharge or neon tube. The meter *M*, measures the current of the controlled r-f tubes. If a resistor *R* is inserted, as the plate current of the tubes decreases, the voltage between points *A* and *K* increases. This causes the gaseous discharge to increase in area and hence travel up the long cathode. The motion of the glowing gas discharge replaces the moving pointer of the meter. The height of the discharge is proportional to the increase in voltage between *A* and *K* above the voltage required to just start the climb. In the tubes as manufactured (under various trade names such as Tunalite, Flashograph, Tonebeam, etc.), the height of the column is also directly proportional to the current flowing between cathode and anode which is approximately two ma. at full column. The third electrode was provided to create an initial ionization which gives a much more dependable action than if but two electrodes were used. This third electrode is generally connected to a point about 40 volts more negative than *K* through a current limiting resistor of one-tenth to one-quarter megohm.

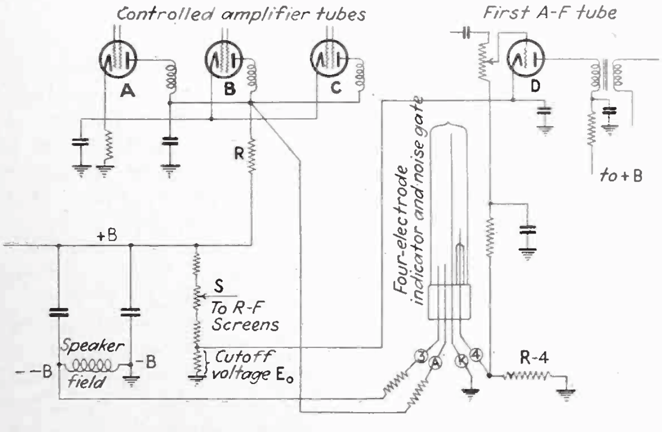


Fig. 4—Circuit of four electrode gaseous tube as tuning indicator and noise gate

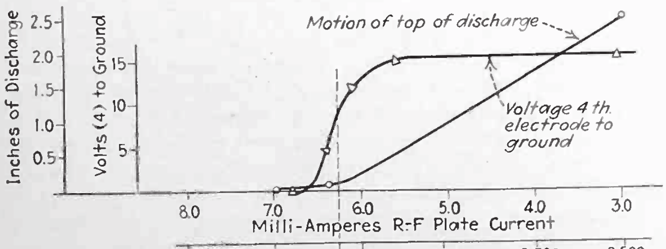


Fig. 5—Characteristics of indicator tube when adjusted to exclude signals below 200 microvolts

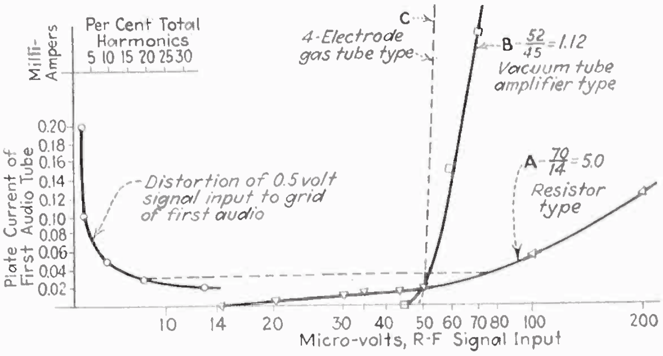


Fig. 6—Characteristics of three noise-gate systems

Figure 3 illustrates a magnified portion of the station selector dial in the vicinity of the 660 kc. signal. The curve directly above the calibrations illustrates the height of the gaseous discharge as the receiver is adjusted through the signal.

In turning the station selector from 650 kc. toward the desired signal at 660, the action is as follows: first, noise up to 654 kc. gradually increasing signal accompanied by bad hiss up to 658 kc., fair reception of signal up to 659 kc. Good reception is then enjoyed for the small space of 2 kc. and the action is then repeated in the reverse order on the other side.

Referring again to Fig. 2, adjustment of the potential of point *K* is desirable to take care of variations in (1) line voltage, (2) normal plate-current of r-f tubes and (3) variations in the indicator itself. The first two of these variations are present even though a conventional meter is used. The third has been greatly minimized so that the adjustment *K* is no longer essential.

Several prominent manufacturers have used the gaseous discharge tube as a tuning indicator for over a year and have found it satisfactory. Recently, experiments have been under way by Professor Senauke and the writer, to utilize this type of tuning indicator for a noise gate as well. The addition of a fourth electrode and certain circuit changes give promise of doing this, even better than the present methods employing vacuum tubes.

In Fig. 4, the essential elements of circuit employing the four-electrode tube are illustrated. Tubes A, B, and C are the ones controlled and the action of the electrodes (3), (A), and (K) is the same as previously described for the tuning indicator action in Fig. 2. In this illustration, the fourth electrode (4), is insulated with a glass stem to a point about one-half inch above the lower ends of the other electrodes. This electrode is connected through a resistance (one-quarter to one-half megohm) to ground. It is also connected through a low-pass filter to the grid return of the first a-f tube. The cathode of this tube is initially biased positively by a voltage (E_o) sufficient to completely cut off its current. The adjustment for both the noise gate and tuning indicator is effected by varying the maximum plate current of the controlled tubes. This is done by means of a potentiometer connection to the screens. Other methods of adjustment are feasible.

To explain the action, a characteristic of a typical four-electrode tube is submitted in Fig. 5. In this figure a curve of the voltage developed in resistor R_4 against plate current of controlled tubes is shown. It will be noted that approximately 10 volts are developed for a very small increment of input voltage. At the same time this action is occurring at the fourth electrode, the visible discharge from the long cathode is climbing as indicated in the second curve. In Fig. 5 the circuit is in adjustment to exclude signals weaker than approximately 150 μv. As the current through resistor R is decreased, the first thing to occur is the motion of the "long cathode" discharge. When this discharge reaches the vicinity of the fourth electrode an additional discharge develops at that point. The discharge there, causes the sudden appearance of a voltage on the resistor R_4, which reduces the bias of the a-f tube and allows the signal to be further amplified and reproduced in the loud speaker. Any signal or undesirable noise which is too feeble to cause the discharge to rise to the electrode will not be heard in the receiver. This threshold value of sensitivity may be controlled by the adjustment S, (Fig. 4). It should be further noted that as stations of greater signal strength are encountered, the voltage does not greatly increase over the value initially released. This is valuable in preventing the working bias on the audio tube from becoming too low.

In all circuits which provide "noise-gate action" to an AVC receiver, a feature of great importance is the rapidity (with respect to signal strength) with which the audio tube is put in operating condition. If the action is slow, stations which have signal strengths in the region corresponding to the release of the over-bias, will be distorted. It is obviously desirable to maintain this region as small as possible.

In Fig. 6, the release of the first audio tube, by means of three different noise gate systems is illustrated. The receiver used was the one already mentioned, in which the audio tube was a triode (56) which required a rather high grid bias to produce cut-off. Curve A is for the receiver with no additional tube, but with resistors arranged in such a way that the variations of the plate current of the controlled r-f tubes cause the cut-off and release of the audio amplifier. On the left, another curve is drawn to the same scale of ordinates, but with percentage distortion as the abscissa scale. If 20 per cent is taken as the upper limit of distortion compatible with tolerable reception, it is to be noted that all stations within a region having approximately 5 to 1 signal strength ratio will be distorted.

Curve B represents the action when the receiver is equipped with a silencing tube of the screen-grid, d-c amplifier type. The action is very sharp and represents about the best that can be done by conventional methods. The region of distortion has an input signal strength ratio of 1.12 to 1.

Four-element gaseous discharge tubes provide actions all the way from curve B to curve C, which it will be noted is extremely abrupt. The increment of input voltage between zero current in the first audio tube and a value to give good reception is too small to be measured on a standard signal generator.

It is felt that this new gaseous discharge tube should prove interesting to the set designer because it combines tuning indicator and noise gate. The addition of the noise gate can be effected with practically no additional expense over that required for the tuning indicator alone.

* * *

A NEW BOOK ON AN ELECTRONIC SUBJECT

Radio Engineering

By Frederick Emmons Terman, Associate Professor of Electrical Engineering, Stanford University. Published by McGraw-Hill Book Company, 1932. 688 pages; 418 figures. Price $5.

THERE IS NO DOUBT THAT an up-to-date complete text on radio engineering was overdue so that the most radio engineers will buy Professor Terman's book without looking at it. It gains when examined in some detail. First in what we might call the routine matter of radio engineering, such as circuits, general properties, an agreeable surprise is in store: the mathematical developments have been cut down to a little over 250 lines (not pages) apart from a certain number of foot-notes. Strangely enough the cut in mathematical equipment has been made possible by giving more space to important demonstrations likely to be of use over and over again. The discussion of the resonance curve is a noteworthy example; it is more detailed than in most other radio books, and the author adds to the proposed universal resonance curves one of his own which has much to recommend itself. It is followed by a chapter on coupled circuits in which, to mention only one detail, ten full resonance curves, all relating to the broadcast band, are reproduced. The treatment of vacuum tubes is brief, but sufficient, as we may look forward to Chaffee's book on this subject. This leaves room for a thorough discussion of the audio and the radio amplifier. By reducing the resistance-, impedance- and transformer-coupled audio amplifier circuits to their equivalent, the ideas are clarified and the mathematical steps cut down. A welcome feature is the theory of the transformer-coupled audio stage; a similar discussion had only been available in scattered German publications. Class B and C amplifiers are also described. In the field of vacuum tube oscillators which quite logically follows the chapters on amplifiers, it is pleasing to see the section on practical circuits having high frequency stability and the corresponding page of diagrams. As might be expected the chapter on detection is well handled.

With the exception of 50 pages devoted to radio receivers (as they are, not were) the second half of the book is devoted to more professional problems, such as modulation, sources of energy, radio transmitters, antennas, radio waves and radio measurements.

Some difference of opinion might arise with respect to the footnote references, in which the attempt is made to cite a limited number of comprehensive articles, about 75 in the first half and about 170 in the second half of the book. While noted in a uniform system the number of the first and last page of the article might well have been indicated as is now the almost universal habit, and the method followed in the radio abstracts in the *Proc. I. R. E.*, the *Engineering Abstracts*, the *Wireless Engineer*, etc. It would also have been useful to cite more books (Jolley, Vigoureux, O. B. Wood, R. T. Beatty, etc.) on subjects which could not be fully explained. On the other hand, it is very difficult to see why Professor Pedersen's book is mentioned four times whereas Professor Appleton who has carried out so many experimental investigations has to be content with a 1928 reference.

The index is more complete than might be thought at first sight, but one looks in vain, for instance, under damping, transient, grid current, etc. These are all minor matters and by insisting upon concrete examples rather than formulas, facts rather than theories, Professor Terman has created a text of the greatest interest to the engineer as well as to the amateur who is not satisfied with superficial knowledge.

There is one reduction in mathematics not to be overlooked: the price is unusually low for a book of this kind.

Thyratron controlled voltage rectifiers

By H. W. HARTMAN
Vacuum Tube Engineering Dept.
General Electric Company

ONE of the most recent developments in Thyratron-controlled rectifiers for laboratory use makes possible obtaining uniform voltage control throughout the entire voltage range from zero to the maximum voltage of the rectifier.

The control of this rectifier, three-phase, full-wave, is obtained by changing the phase relation between the grid and plate voltages of the Thyratron tubes by the use of a three-phase Selsyn transformer. The secondary winding is connected Y and mounted on a rotor with a leg of the Y connected to each grid of the three Thyratron tubes (FG-29), and by turning this rotor from 60 degrees to 90 degrees full 100 per cent uniform regulation can be obtained in the direct-current rectified voltage, or from zero to maximum voltage.

Figure 1 illustrates the relation of the d.-c. grid voltage of the Thyratron (E_o), a.-c. plate voltage of the Thyratron (E_p), a.-c. voltage impressed upon the grid by the Selsyn transformer (E_s) and the tube characteristic (E_d) for one phase of the rectifier, the other two phases simply follow in sequence.

At the point (O) where the Selsyn voltage meets the tube characteristic curve (E_d), the tube breaks down and carries current for the length of time shown by (T).

The Selsyn voltage curve (E_s) can be shifted to cause the tube to carry current for a longer or shorter period of time as desired.

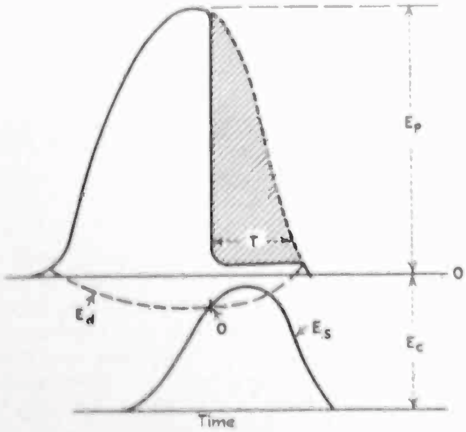


Fig. 1—Relations in the controlled cycle

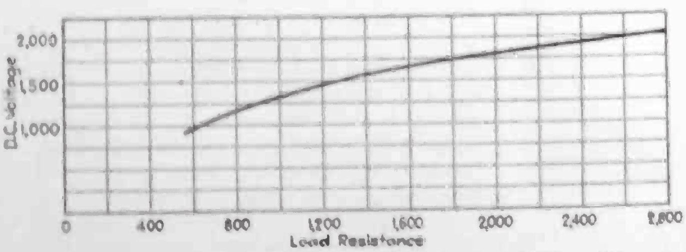


Fig. 2—Regulation curve for Thyratron-controlled rectifier

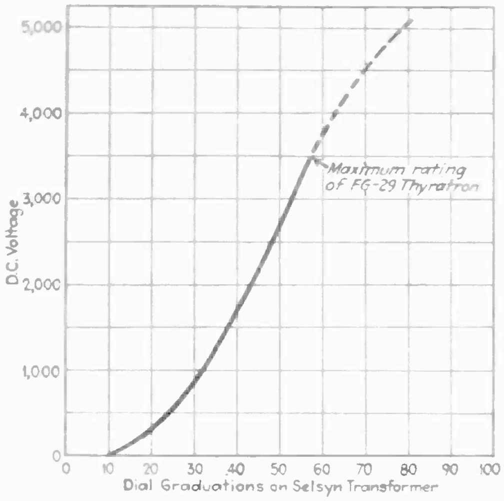


Fig. 3—Curve showing control of rectifier

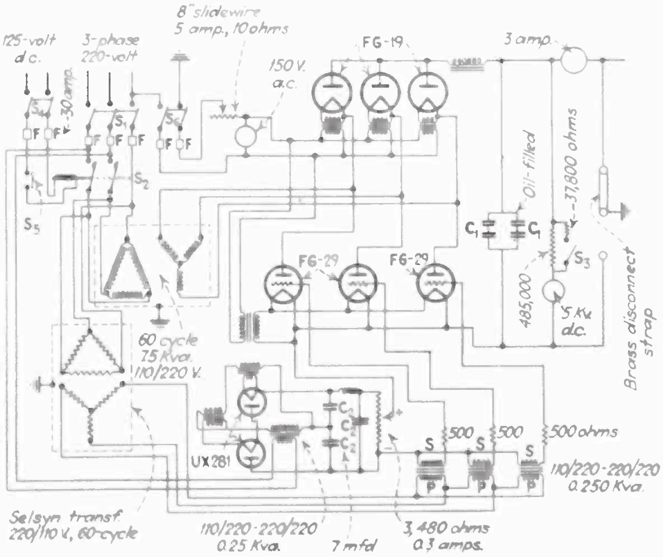


Fig. 4—Diagram of 7.5 kva., 5000-volt rectifier

This type of rectifier is suitable for applications above about 2,000 volts direct current as in such cases the cost of d.-c. generators rises rapidly. By proper choice of tube types d.-c. voltages up to 10,000 are obtainable.

Figure 4 is a wiring diagram of the 7.5-kva., 5,000-volt rectifier now in use.

The advantages of this type rectifier are:

(a) Uniform control over full range.
(b) Eliminates the induction voltage regulator.
(c) Reliable. Easy to operate.
(d) Can be used for remote control without any great additional cost.
(e) The voltage regulation can be compounded by adding another circuit to the grid of the Thyratron.
(f) The space used could be much less than the space required for an induction voltage regulator or motor generator set.

HIGH LIGHTS ON ELECTRONIC

Opposed photronic cells responsive, independent of general illumination

An ingenious plan for making photocells of the Weston photronic type unresponsive to general changes in daylight illumination, while still responsive to local spotlight changes, is reported by Horace H. Raymond, consulting engineer, Berlin, Conn. He accomplishes this by using two photronic cells, connected with opposite polarities together. The two cells thus "buck" each other for all general changes of illumination and so fail to operate the relay connected in parallel with them. But if either one of the cells is lighted separately, enough current is generated to unbalance the circuit and work the relay. Mr. Raymond has found this arrangement to work well on a garage-door control, the set-up being unresponsive to daylight, yet instantly operable by a headlight beam directed on one of the cells.

The cells are mounted on a wooden board about 12 in. long and connected together so that the positive terminal of one is connected to the minus terminal of the other. Two leads are then brought from the terminal of one of the cells to the terminal of a sensitive relay. The board containing the photronic cells is then placed inside the garage in line with one of the glass windows in the top of the door. The cells may be placed on the side wall or on the ceiling and may be exposed to strong daylight, the only precaution being to place them so that the sun does not strike them.

As long as both cells are equally illuminated by daylight, no current flows through the sensitive relay. If, however, one of the cells is illuminated, the current output of that cell is greater than the current output of the other, so that we get a flow through the sensitive relay which can be used to control the door operating mechanism. Since it is likewise true that darkening one of the cells or the other will produce the same effect, it is necessary to place the cells high up where the shadow of passing persons will not affect them.

"This arrangement is very stable and has been in use on my garage for a number of weeks without adjustment, the current being left on night and day," writes Mr. Raymond.

"This same principle can be used for interrupted beam application out of doors or in well lighted buildings without the necessity of providing a hood. In this case the light source is trained on one of the photoelectric cells only. If two light sources are used, one for each cell, directional counting may be performed."

✦

Rotations of frictionless meter counted

The Builders Iron Foundry, Providence, R. I., has developed a special line of turbine meters for measuring the passage of steam, gas, etc. The gas or fluid flows through a restricted area and spins a freely-running propellor blade which rotates proportionately to the quantity of fluid passing.

In such a meter, however, it is essential that the turbine blades be not loaded sufficiently to slow them down and give incorrect readings. For this reason the development of such turbine meters has been restricted, since it is not possible to extend the shaft of such a turbine runner through packing-glands to operate an external counter.

The problem of counting the rotations of the free-running turbine blades is now accomplished readily enough by means of a photo-cell which responds to the light impulses coming through the glass window in the valve housing, as the vanes rotate. In this way an accurate count of the rotor revolutions is kept, without imposing the faintest load on the rotor itself.

✦

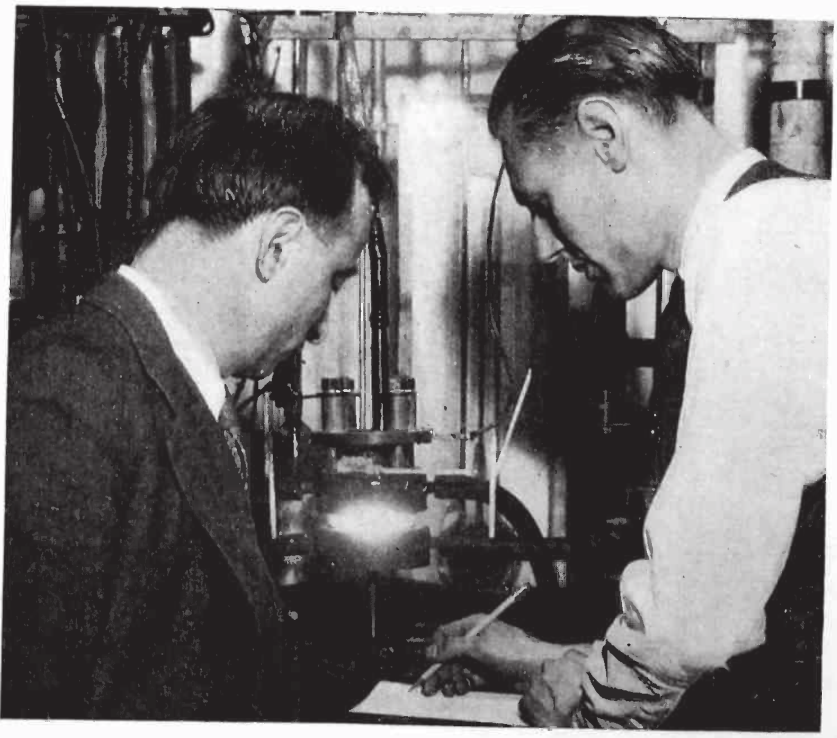
Amplifier music for patients during operations

Members of the New York Society of Anesthetists recently demonstrated the power of music to assuage discomfort during surgical operations, by delivering appropriate musical selections directly to the patient, without interfering with the conversation of the surgeons and nurses. In co-operation with Erpi experts, Dr. A. F. Erdmann, noted surgeon, has been experimenting with sound therapy for several years.

"The new electromagnetic pickup," Dr. Erdmann said, "transmits the music from the phonograph record to an individual patient, without inconviencing or distracting the attention of others who may be in the room. It serves to divert his attention from the operation—keeps his mind off what is going on about him, and shuts out the conversation of those performing the operation, which sometimes has an unfavorable effect."

✦ ✦ ✦

CARBORUNDUM CONTROLS MERCURY-ARC



The new Slepian-Ludwig method of controlling a mercury arc by means of a high-resistance rod partly immersed in the mercury pool, was exhibited at the January convention, A. I. E. E.

DEVICES IN INDUSTRY + +

Industrial X-rays for examining metals

An X-ray machine built especially for the industrial field for the radiographic examination of thick sections of metal, is rated at 10 ma. and 300 kv. peak for continuous operation and employs the so-called doubling circuit using two kenotron tubes as rectifiers. Condensers are placed in series with the tubes and the high-tension transformer. The condensers serve to boost or double the voltage supplied to the X-ray tube by the high-tension transformer on the useful half cycle.

This increase to 300,000 volts for continuous operation of X-ray tubes permits the rapid X-ray examination of steel sections up to $3\frac{1}{2}$ in. in thickness and by longer exposures satisfactory examination of steel up to at least $4\frac{1}{2}$ in. in thickness. Consistent operation of the apparatus and the stability of the X-ray tube developed for this high-voltage has made it possible to examine welds of heavy steel plates as a routine procedure.

◆

A "rogue's gallery" of talking films

The use of sound pictures as a means for the identification of criminal suspects would in itself be invaluable, according to a writer in *The American Journal of Police Science.* The ordinary "rogues' gallery," as it exists today, furnishes us with very little—a still-life full-face view, a profile, and a verbatim description. This is at best a clumsy and inaccurate means of identification, used for general leads rather than positive proof. The growth of a mustache or beard is enough to render such photographs practically useless. In many states the use of fingerprints is limited by legal entanglements. The substitution of a collection of living "speaking" representations will be a distinct advance in the technique for establishing the identity of criminals, furnishing what Professor Moley calls "a fourth dimension" of identification which leaves no aspect of the prisoner unrecorded. It will be an incalculable aid to any police organization or prosecuting office and may aid in abolishing some of the questionable tactics of these officials which they now feel to be indispensable in establishing their cases and preserving semblances of efficiency.

There is now a concerted attempt under way to establish a central bureau of information and records, to be supplemented with sub-branches in the larger cities, which in turn serve as collection centers for the smaller districts. At the same time, however, the flow of information can be directed outward, from the center. Pre-supposing a complete movietone library in existence at the central criminal bureau, it is easy to imagine the possibilities for the use of films in a nation-wide hunt for any particular man. Small, indeed, is the town which has no moving picture apparatus. Through the distribution of the films as needed would be molded an extremely strong organization for the discovery and apprehension of criminals, carrying to the smaller cities and towns the advantages and resources of the better equipped and more efficient police.

Aside from its value to the witness and the police, the movietone could serve as a broadcasting agency for arousing the interest of the general public. Few people take particular notice of a post-office bulletin describing a "man wanted." How many read carefully a newspaper description of a suspect? But few would fail to be interested in a living advertisement of "I am wanted."

What man planning to commit a crime would not think seriously of his chances of detection and escape when he may appear, walking and talking, before the eyes of thousands scattered throughout the country?

Photoelectric photometer tests air purity

Harvard Observatory has a valuable new research instrument in a photoelectric photometer designed by W. A. Calder to study the luminous intensity of faint and brighter stars and tested recently in the more mundane field of air purity investigation at the Harvard School of Public Health.

While the apparatus is primarily for astronomical use it may be employed for highly precise measurements, particularly of faint light as in basic analyses bearing on air conditioning, notably in evaluating the concentration of dust particles in segregated volumes. It occupies only about one cubic foot of space and utilizes a Kunz photoelectric cell and Lindemann electrometer in translating light intensities into scale readings. A Telechron clock motor is provided to drive the sectors requisite to equalize the light of the star under investigation with that of the comparison star. Amplification of light values along the line practiced by Professor Joel Stebbins with vacuum tubes is under consideration in connection with this photometer. The illustration shows the device attached to a telescope with a 3-in. lens for the study of colar corona luminosity during the recent solar eclipse.

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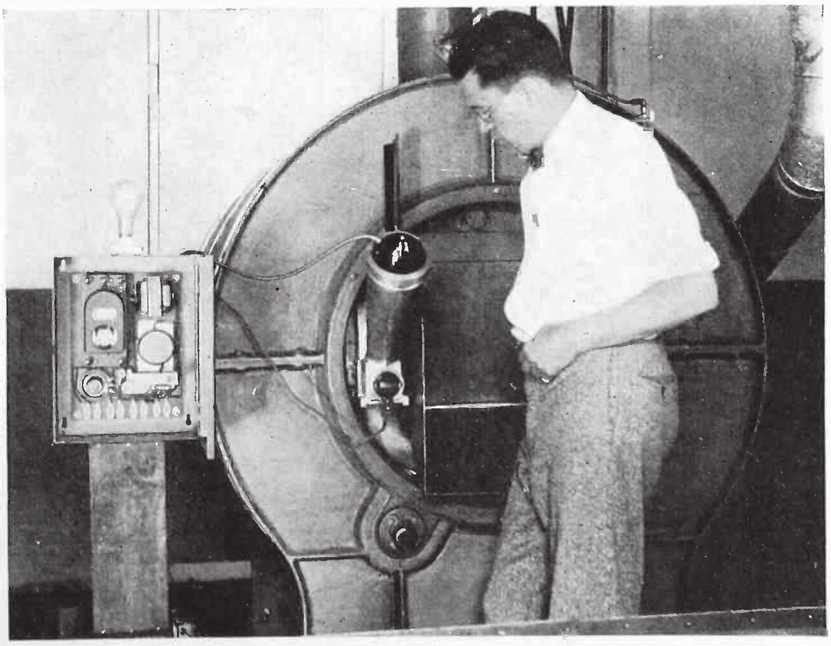
PHOTO-CELL SIGNALS WHEN COFFEE IS ROASTED



When coffee in this McCormick roaster reaches that particular shade of golden brown which indicates that the ideal roasting has been secured a Weston photoelectric cell notifies the supervisor to recharge the roaster

An electronic phase-failure relay

By C. STANSBURY and
G. C. BROWN

*Research Engineers,
Cutler-Hammer, Inc.*

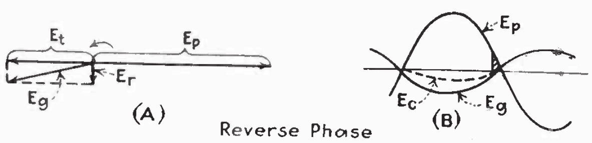


Fig. 2—Normal phase relations in circuit

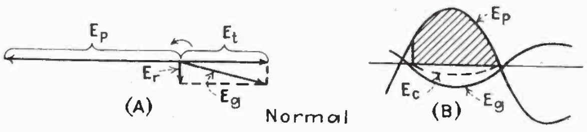


Fig. 3—Effects of a phase reversal

THE applications of electronic devices in industrial control apparatus fall in two general classes: Those in which the electronic apparatus performs functions which cannot be performed by other known apparatus, and those in which it has to compete with other means having the prestige of years of successful service. The application described in this article falls in the latter class, as electro-magnetic devices for performing functions similar to those described have been in use for years and it is only due to their superior characteristics and performance that the electronic arrangements described are coming into use.

Where a polyphase (generally three-phase) a.c. motor is used for driving an elevator or hoist, it is necessary to so arrange the controller as to prevent operation of the motor unless the supply voltage conditions are correct. For instance, if the phase rotation of the supply voltage is in the wrong direction (which may possibly be the case, due to switching or maintenance operations on the power distribution system) the motor will run in the "up" direction when the controller handle is put in the "down" position, and vice versa. This is obviously a dangerous condition, and is ordinarily combated by including in the controller a relay which distinguishes between correct and incorrect phase rotation, opening its contact and making the controller inoperative in case the latter occurs. Similarly, dangerous conditions result from the failure of one of the supply lines, resulting in single phase instead of polyphase supply and from other abnormal voltage conditions. The protective relay should be so designed as only to close its contact when no such dangerous conditions exist; that is, only when the supply voltage conditions are perfectly normal and satisfactory.

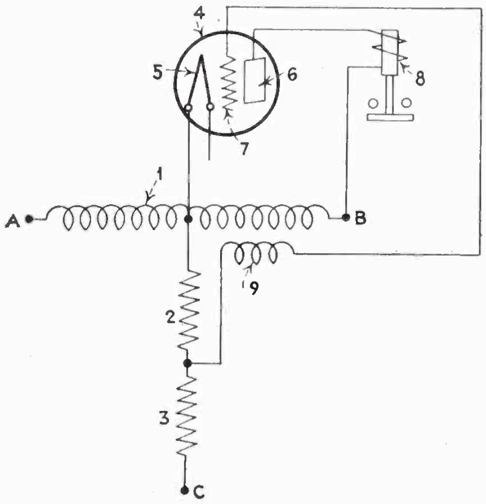


Fig. 1—Elementary diagram of the phase-failure relay

There are three general types:

1. Relays using the rotating magnetic field-induction principle, in which a movable member responds to the direction of rotation of a field induced by the supply current or to its failure to rotate due to single phase condition.
2. Multi-coil relays depending on the change in phase relation of the currents in the various coils under normal and abnormal conditions.
3. Voltage-sensitive relays connected in a network of resistors, reactors, etc., in such a way that abnormal phase conditions produce low voltage, causing the relay to respond. This method has the weakness that it is very difficult to devise a network in which such voltage changes resulting from abnormal conditions are materially greater than the range of the normal operating voltage which must be provided for.

Advantages of electronic apparatus

There are a number of desirable objectives in setting out to design an electronic substitute for the above. Some of the advantages which prove to be obtainable are:

1. Greater simplicity and cheapness. The electronic and auxiliary apparatus used is of standard type, suitable for a large number of other uses.
2. Functioning can be made inherent in the circuit and need not be dependent on the proper functioning of delicate moving parts, light contacts, etc., all such parts being eliminated.
3. A.C. elevator and other motors are often controlled by contactors and relays which use d.c. in their coil circuits. Electronic phase protection apparatus offers the opportunity to provide such protection with the same tubes which also furnish the rectified current for these coils, the only additional apparatus required being simple and cheap. On the other hand, there is the disadvantage of the cost and inconvenience of occasional tube replacement. This factor diminishes with the improvement and cheapening of the tubes which is inevitable.

The relay described below is of what may be termed the shunt type, as it responds to the voltage conditions of the lines feeding the load; as contrasted with the series type of protection which responds to phase relations of the currents passing to the load. The former type is suitable for applications like elevators where the motor is stopped frequently. If the line voltage of one phase fails while the motor is running, the counter-voltage generated in the motor will hold up the voltage of the respective line, and prevent the relay from functioning until the motor approaches rest. This is desirable in an elevator so that a landing can be reached before the elevator so that a landing can be reached before the equipment is shut down by the relay. A method of electronic protection of the series type, not covered by this article, but operating on the same principle, has been developed for protection of motors which run more or less continuously.

The electron tube circuit

Figure 1 is an elementary diagram of the system. The tube is of the grid-controlled gas rectifier type. The method of control makes use of the well-known principle of shifting the phase of the grid voltage with reference to the anode voltage. But, instead of using such phase shift control in the way most commonly described, as a means of taking any portion of the half wave desired and thereby adjusting the r.m.s. current, advantage is here taken of the fact that there is one critical phase position of the grid voltage from which a slight shift in phase in one direction makes the tube conduct during practically the entire positive half-cycle, while a slight shift in the other direction prevents current flow for more than a negligible part of the half-cycle. This is best explained by reference to the other figures in which E_p is the voltage applied to the anode, E_g that applied to the grid, and E_c is the critical potential below which the grid must be kept to prevent the starting of an arc. The network of Fig. 1 has the property that under normal phase conditions the relation of E_g to E_p is as shown in Fig. 2, which permits conduction during practically the entire positive half-cycle; while reverse or single-phase conditions produce the relations of Fig. 3 or Fig. 4 respectively, which substantially prevent any current flow through the tube.

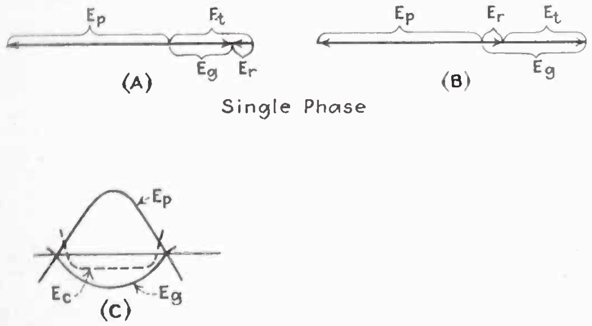


Fig. 4—Single phase circuit conditions preventing flow of current

The voltage E_r in Fig. 2 is due to the IR drop in the resistor 2 of Fig. 1. The voltage E_t is that of the transformer winding 9. These voltages combine vectorially to give E_g, which is shown in Fig. 2B as permitting current to start through the tube near the beginning of the positive half-cycle of the anode voltage. Figure 3 shows the voltage conditions resulting from reverse phase rotation. It is evident that the phase of E_g has advanced relative to E_p enough to block conduction through the tube except possibly for a negligible period toward the end of the cycle. There are a number of possible single phase conditions, depending on which of the three lines fails, and on the type of apparatus connected between the various lines, but when analyzed all such conditions may be reduced to either Fig. 4A or Fig. 4B. The difference lies in whether E_r is in phase with or in opposition to E_p. E_t is always in direct opposition to E_p.

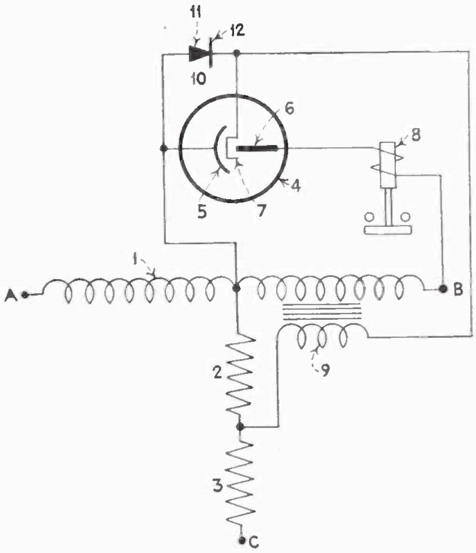


Fig. 5—Use of an auxiliary rectifier in phase-failure relay using cold-cathode tube

It is only necessary to make E_t large enough to give grid voltage which is sufficiently negative to prevent starting of the tube even for the case where E_t is opposed by E_r as in Fig. 4A.

It will be clear that although reference has been made to abnormal conditions such as reverse phase rotation or phase failure, the normal condition shown in Fig. 2 is a critical one and adjustment can be made so that this condition will be disturbed for any desired departure of voltage balance from normal.

When an attempt was made to apply Fig. 1 to a tube of the so-called grid-glow type, difficulty was experienced because the anode current will start in the tube when the grid voltage exceeds either a definite positive or a definite negative critical value, such critical values being of the same order of magnitude, somewhere between 200 and 400 volts, depending on circumstances. The requirement was that under normal conditions the grid voltage should in every cycle exceed one of these critical values and so cause the tube to conduct, but must not exceed either critical value when abnormal conditions exist. It was not found possible to meet this requirement by phase shift means alone, but the problem was solved by introducing the auxiliary rectifier (preferably of copper-oxide type) shown as 11 in Fig. 5. This rectifier permits making the grid potential sufficiently positive to reach the *positive* critical potential, but at the same time prevents the grid from reaching the *negative* critical grid potential. With this addition the functioning is substantially the same as that described for Fig. 1.

A number of elevator controllers using the arrangement described herein are in successful service—two of them having been in service for over two years.

The application should be of particular interest to advocates of electronic methods because of its success in direct competition with old and well-tried electromagnetic methods.

+ + + ELECTRONIC NOTES

Magnetic control of mercury vapor rectifier tubes

By Herbert J. Reich*

Since the development several years ago of the hot-cathode thyratron, quite a number of articles have been published concerning the various methods by which the grid may be used to control the anode current. It does not appear to be generally known, however, that equally satisfactory results may be obtained by using a magnetic field instead of the grid as the controlling element.

A magnetic field in the region between anode and cathode, preferably close to the anode, and at right angles to the path of the anode current, will increase the anode voltage necessary to cause the tube to break down. The critical anode voltage increases with field strength, so that the magnetic field produces an effect similar to negative grid voltage.

If a permanent magnet or other form of unidirectional field is used in conjunction with a tube supplied from an a.c. source, increase of field strength may be made to decrease the average anode current continuously from its maximum value to a value approximately half as great. Beyond this point further increase of field strength will reduce the current suddenly to zero. By means of an electromagnet energized from the same a.c. source as the anode, the current may be varied either continuously or suddenly from maximum value to zero. This may be done by varying the phase of the magnetic field with respect to the anode voltage, by maintaining a constant phase displacement between the magnetic field and anode voltage and varying the strength of the field, or by a combination of these methods. The explanation of the action of the tube for these various methods of control is similar to that when a grid is used as the controlling element[1]. The secondary of a model T Ford spark coil has been found to make an excellent electro-magnet for this purpose, both with and without a core. By proper design of the core the exciting current may be as small as ten or fifteen milliamperes, which compares favorably with the grid current required by thyratrons. Many simple circuits may readily be designed for varying the phase of the exciting current with respect to the anode voltage.

The anode current may also be controlled in many mercury vapor rectifier tubes by means of a high frequency electromagnetic field, even when a small oscillator is at a distance of several yards from the tube circuit.

It is apparent that the use of a magnetic field in place of a grid in controlling the current passed by hot-cathode mercury vapor rectifiers may be of considerable advantage, since a simple two-element rectifier tube is usually much less expensive than a grid-controlled tube. It should be pointed out, however, that magnetic control is not effective with the type of recifier tube in which the anode completely surrounds the cathode.

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*Dept. of Electrical Engineering, University of Illinois.

[1] A. W. Hull: "Hot Cathode Thyratrons", G. E. Rev., Vol. 32, No. 7, July, 1929, 390-399.

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High frequency ceramic material

A new ceramic body having characteristics of interest to workers at high frequencies has been developed in Germany and will soon be available in this country. It is reputed to be useful where accuracy of dimension and high dielectric and mechanical strength are desired. The data below were taken in accordance with the standards established by the German Ceramic Society.

PHYSICAL AND ELECTRICAL CHARACTERISTICS

Specific weight	2.6–2.7
Dielectric strength, kv/mm	35–45
Dielectric loss	See below
Dielectric constant	6.5–7.1
Compressive strength, lb./sq.in.	96,000–118,000
Transverse strength, lb./sq.in.	14,700–19,000
Impact strength, cm kg/cm²	4.0–4.5
Tensile strength, lb./sq.in.	3,700–9,000
Linear coefficient of expansion	7.8

The dielectric loss varies with frequency as follows:

Frequency in kilocycles	Dielectric loss in per cent
100	0.21
1,000	0.16
3,000	0.15
4,300	0.14
8,600	0.11
12,000	0.10

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Permeability of iron at ultra-radio frequencies

J. Barton Hoag and Haydn Jones, of the University of Chicago, report in the *Physical Review*, November, 1932, that the magnetic permeability of iron falls gradually from the value 30 at 469.8 megacycles (63.8 cm.) to 22 at 589.8 mc., 18.7 at 829.8 mc. and 9.65 at 1,350 mc. (22.21 cm. waves). These are the first measurements made with undamped waves; they suggest that as the frequency increases the magnetic premeability of iron tends toward unity, the value for empty space.

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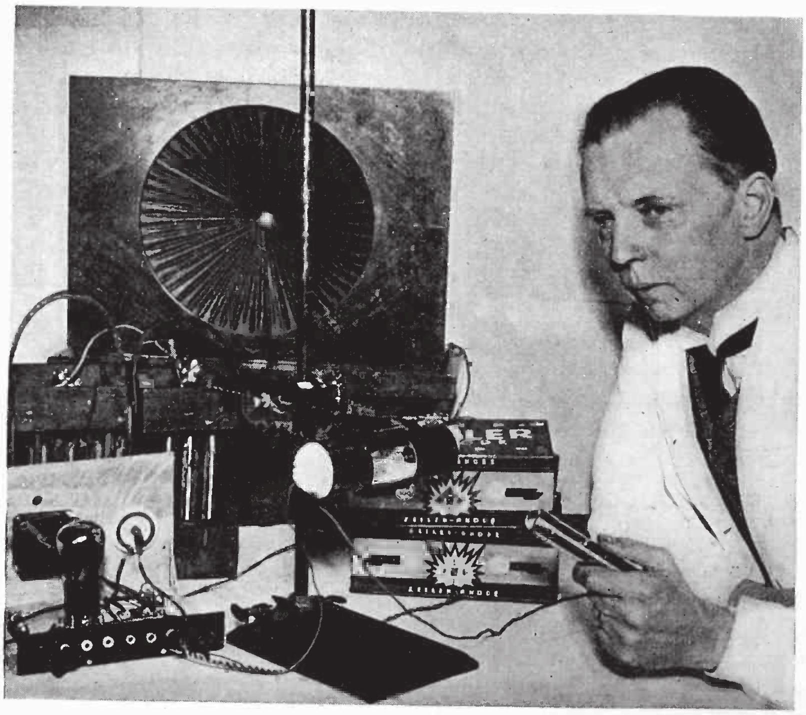
MUSIC WITH A FLASHLIGHT



Joachim Winckelmann, Berlin, sends a continuous current through a selenium cell; when light falls on the cell a tone emitted by an oscillator varies in frequency with the intensity of illumination

FROM THE LABORATORY + + +

Electronic microscope—studies of electronic emission

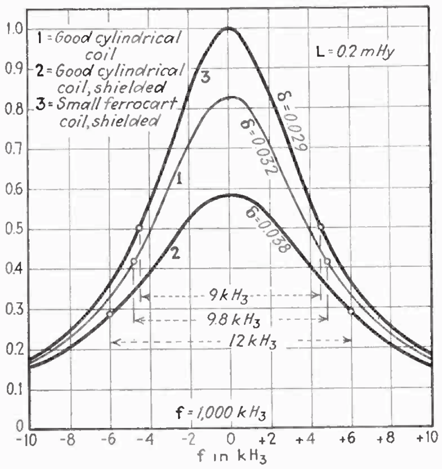
In an interesting series of experiments M. Knoll, F. G. Houtermans and W. Schulze, of the Berlin Institute of Technology, use was made of the magnetic field produced by two short coils for focussing electrons issuing from an incandescent oxide-coated cathode. An enlarged image of the emitting surface was obtained upon a screen of zinc sulfide for visual observation, a zinc sulfide silver phosphorescent layer for photography. The electronic microscope shows that the emission of an oxide-coated cathode is much less uniform than might be thought from the appearance of the surface. Photographs made by the microscope may be found on page 377, December *Eectronics*. On heating the cathode when the plate potential is zero, the emission becomes uniform for a moment, but in a fraction of a second active specks or channels are formed; the negative space charge which builds up near these zones tends to make the image hazy. Oxide-coated cathodes with uniformly emitting surface show distinct saturation; no saturation is obtained up to 2,000 volts when active zones are present, no doubt merely on account of the uneven distribution of the space charge. This work was described in the *Zeitschrift für Physik*, October 1932, and a photograph of the electronic microscope will be found in January, 1933, *Electronics*, page 23.

✦

Tuning coils wound on magnetic cores

Considerable interest abroad has been aroused by a new magnetic core developed by Hans Vogt, Berlin, on which inductances for tuning circuits may be wound. The material is called "Ferrocart" and makes possible the construction of compact inductors with small external fields and with low losses. In these respects the material seems to resemble the Polyiron cores developed in this country and discussed widely a year ago.

"Ferrocart" consists of minute particles of a high-grade magnetic material. These individual particles are themselves quite free from losses, and are arranged by means of a special insulating process so that the formation of eddy currents and the losses resulting therefrom are reduced to a minimum. The magnetic losses in the case of wave lengths of 200 to 600 meters, are reported to be less than the high frequency losses occurring in copper. However the new material possesses a considerably greater magnetic conductivty than air so that the amount of copper employed can be decreased and therefore the copper losses avoided.



The material itself is made in the form of plates or rolls of different dimensions, from which the individual cores for the coils are worked in the necessary dimensions. The material is easy to work, can be stamped out and sawed. Individual parts can be pressed together by employing pressure and heat.

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Photometry of stars by means of a photo cell and a low grid-current tube

Greatly improved results in the photoelectric photometry of stars are obtained according to A. E. Whitford, of the Washburn Observatory, Madison, Wis., when instead of measuring the photoelectric effect produced in the cell (sensitivity 220 μa per lumen) by means of an electrometer, it is amplified with aid of a low grid-current tube (FP 54). The photoelectric cell (sensitized sodium) and the vacuum tube are placed inside a metal container which can be fastened to the ocular tube of the telescope and evacuated to 1/100 mm. of mercury. The high resistances required (14,000 and 74,000 megohms) have been secured from the S. S. White Dental Manufacturing Company. The single stage amplifies over two million times, and when the device is placed near the focus of the 15-inch refractor, the current produced by stars of 14th magnitude can be measured by a sensitive galvanometer. (This corresponds to the light from a standard candle "seen" from a distance of about 250 miles). The report of this work will be found in the *Astrophysical Journal*, November, 1932.

The cesium-oxygen silver photo cell

Thirteen commercial cesium-oxide photoelectric cells representing three different types of vacuum and three gas-filled tubes, were exposed by J. C. Peters and E. B. Woolford, Leeds and Northrup Company, to the light from a 6-volt, 18-ampere projection lamp run at 10 amps. (1,545 deg. C.) At the end of 820 hours the light was shut off for 200 hours; after 1,300 hours the e.m.f. (45 volts for vacuum and 90 for gas-filled cells) was removed for 200 hours, the current being measured once daily during all this time in a separate test set. According to the report published in *Physics*, October, 1932, the PJ-14 cell has the most constant results. Gas-filled cells may decrease or increase in sensitivity over 100 per cent after a few hundred hours. Changes following the deposition of minute amounts of cesium are described by Prescott and Kelly, *Bell System Technical Journal*, July, 1932. See also *Electronics* Digests, February, 1932.

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World's largest medical magnet

What is believed to be the largest magnet constructed for medical purposes has been installed in the St. Louis University School of Medicine. This magnet weighing 3,000 pounds represents an investment of $20,000 and is a memorial to Colonel E. L. Bingham former chief medical officer at the Jefferson Barricks. The instrument is reported to resemble a cannon with a steel cone at the muzzle. It is mounted on a bronze bell-shaped base. The cylinder is 71 in. long, 12 in. in diameter and is wrapped with 1,500 lb. of wire. It is powered from a 250-volt, 50-hp. generator located in the basement.

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Bridge and new compensated vacuum-tube voltmeter

A robust thermionic voltmeter is described in the *Philosophical Magazine*, July, 1932. The author, A. S. McFarlane, states that it measures accurately to tenths of a millivolt while its zero remains unaffected by gross changes in the A and B voltage supply. Two arms of the Wheatstone Bridge consist of triodes, and an expression is deduced and verified for the condition that the bridge may be simultaneously balanced and compensated against fluctuations in the supply voltage.

Acoustically compensated volume control

for radio and phonograph sets

By I. WOLFF and J. I. CORNELL
Engineering Department,
RCA Victor Company, Inc.

IT IS commonly observed that there is usually some optimal loudness at which reproduced music or speech from a radio set or phonograph sounds most pleasing. The general effect is that music loses its body when reproduced at low volumes and speech sounds acoustically tubby when reproduced at high volumes.

The cause for this effect can be traced to the variable frequency response of the ear to tones of different intensity. Careful measurements have been made, principally at the Bell Laboratories, to determine the loudness (psychological effect) of various pure tones on the human ear. These experiments have usually been conducted by having a number of listeners compare a pure tone whose intensity and frequency can be varied with some standard tone, generally at 1,000 cycles. Corresponding to every reasonable intensity of the 1,000-cycle tone, there is an intensity of the tone of the other frequency which will sound equally loud. If the points corresponding to equal loudness for a series of tones covering the frequency range are plotted in terms of the physical intensity (sound pressure), a curve known as a "loudness contour" curve is obtained. This curve, as its name and method of attainment imply, shows the various intensities which are required in order to maintain the same loudness at different frequencies.

It is found that equal increments of sound intensity do not cause the same increase in loudness at all frequencies and the loudness contour curves crowd together considerably at the low frequency end, indicating that when a complex tone is increased in intensity the low frequencies become relatively more important, and when it is decreased in intensity the low frequencies become relatively less important. If the tone is attenuated sufficiently, the low frequencies even drop below the threshold of hearing, while the higher frequencies may still be readily distinguished. A series of loudness contour lines, taken from a paper published in the *Physical Review* by B. A. Kingsbury, is shown in Fig. 1 and illustrates this effect.

Let us assume that the volume control on the radio set is so constructed that it does not change the frequency response of the set. Most volume controls have been built with this aim in view. Let us also assume that the pickup of the sound and the reproduction of the sound cause little distortion of the frequency response. Under these conditions, the reproduction should sound most natural when it is reproduced at the same intensity as it would be heard by an observer listening at the place where he would normally be located to hear the original performance. Due to a proper regard for the feelings of the listeners' neighbors, or possibly to the listeners' own sensibility, radio sets and phonographs are very often run at such a volume that the sound intensity is considerably less than that at which it would normally be heard. In such cases, the effects which have been mentioned above occur and the body of the music is badly lost. If a volume control is constructed so that the low frequencies are raised in almost an inverse ratio to the relative sensitivity of the ear in going from normal volume to the volume at which the sound is to be heard, a compensation results which makes up for the different frequency sensitivity of the ear at the lower volume. Such a volume control is known as an "acoustically compensated volume control."

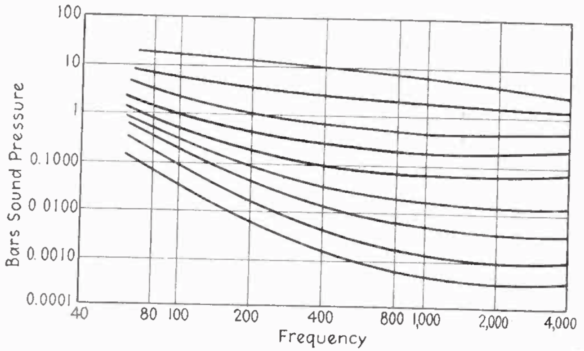
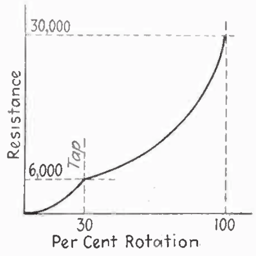
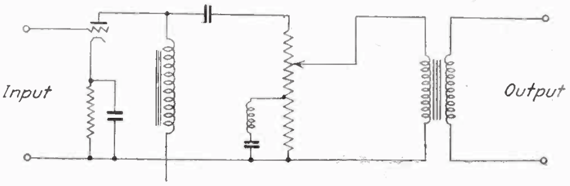


Fig. 1—Equal loudness contours—response of human ear

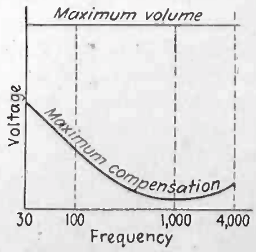
The application of this type of volume control to a radio receiver presents certain difficulties and requires the redesign of the volume control system. The so-called volume control, in many radio receivers, is not strictly a volume control, but a sensitivity control, since it regulates



Left—Fig. 2—Characteristics of volume control resistor



Above—Fig. 3—Circuit diagram of acoustically compensated volume control



Right—Fig. 4—Voltage frequency characteristic of control the radio frequency amplification to compensate for the variation in intensity of the voltage across the antenna and no definite relation exists between the position of the control and the output level of the reproduced sound.

It is essential that a definite relation be established between reproduced sound output and volume control setting and that this level be maintained irrespective of the variation in intensity of the voltage across the input of the receiver. This requirement necessitates a high gain radio frequency amplifier provided with an automatic sensitivity control capable of maintaining the voltage input to the demodulator substantially constant, irrespective of the variation in signal intensity within the sensitivity limits of the receiver. With these conditions established, compensation can be incorporated in the volume control of the receiver to give the required aural compensation for different output levels.

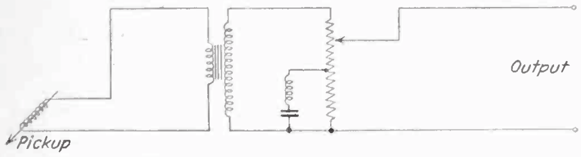


Fig. 5—Circuit diagram of control applied to phonograph

The volume control is located in the audio channel between the plate circuit of the second detector of a superheterodyne and the input to the first audio stage. It may take the form of a tapped potentiometer to vary the voltage input to the audio amplifier stage so as to obtain acoustic compensation. The shape of the resistance rotation characteristic of the volume control is preferably logarithmic in order that the ear may perceive equal increments in volume levels for an equal degree of movement of the control element of the volume control. It has been found desirable to make both portions of the control logarithmic. The resistance characteristics of the control found satisfactory in this receiver are as shown in Fig. 3.

To compensate for the deficiencies in the frequency characteristic of the human ear, and to provide a sound pressure frequency characteristic of the output of the receiver which varies inversely with the ear frequency characteristic (related to normal volumes), an impedance network has been connected from the tap to low side of the volume control. This impedance network, consisting of a series tuned circuit, is resonant at approximately 1,000 cycles and has a relatively broad tuning response characteristic which allows the mid-range frequencies to be attenuated more than the low and high frequencies as the control setting is reduced.

Electrical characteristics of the volume control

The volume control and compensation systems used in this receiver are shown in Fig. 2 and consist of a potentiometer having a total resistance of 30,000 ohms with a tap at 6,000 ohms. The compensation circuit is connected in shunt with the 6,000-ohm section and comprises an air core inductance of 50 millihenries and a 0.5 mfd. capacitor. The ohmic resistance of the choke coil is approximately 520 ohms. The inductance and capacitor are broadly resonant to frequencies in the range of 1,000 cycles, as is shown in Fig. 4. The upper curve in Fig. 4 shows the frequency characteristic of the volume control system with the movable arm set at the high potential end or point of maximum output. The lower curve is the frequency characteristic for the point of maximum compensation. The response characteristic of the system for other adjustments will be located between these limit curves approaching, in shape, the curve to which it is more adjacent.

When the arm of the potentiometer is at the top, maximum compensation occurs and the voltage frequency characteristic is determined by the impedance frequency characteristic of the compensation circuit. Here the signal frequencies in the mid-range are highly attenuated in comparison with the low and high frequency registers and the degree of compensation is determined by the constants of the shunt network.

In the circuit described above, the attenuation of voltage, with the arm at the top, is 14DB with the compensation circuit disconnected. Connecting the compensation circuit results in an additional attenuation of 34DB for frequencies in the region of 1,000 cycles. The voltage output at 100 cycles is up 16DB from that at 1,000 cycles at the point of maximum compensation.

Reducing the volume control setting below the point of maximum compensation has little effect on the shape of the voltage frequency characteristic of the volume control circuit. Care must be exercised in determining the value of the tapped portion of the volume control in order that subsequent circuit constants are not affected when the volume control is adjusted to positions below the point of maximum compensation.

A practical difficulty experienced with this system, at low volume levels, where the low frequencies are exaggerated to give the desired acoustical effect has been that of disagreeable low frequency distortion introduced from certain broadcast signals which has necessitated the addition of a suitable filter to attenuate frequencies below 70 cycles in order that such disturbances as interchannel beat and station generator noises do not mar the quality of the program being received. It is apparent that if audio compensation becomes a standard feature in broadcast receiver design, more care will have to be exercised in broadcast transmitters in order to minimize these low frequency disturbances.

Use with phonographs

The problem of using the acoustically compensated volume control with a phonograph is much simpler. Most records are recorded with the average intensity maintained close to some standard level and any adjustment of the frequency compensation for one record holds for practically all other records. The volume control may, therefore, be compensated without difficulty. A typical circuit used in a commercial phonograph design is shown in Fig. 5. This system also incorporates a tapped control using a shunt resonant circuit, characteristics of which are similar to those previously described.

It may be said that listening tests have substantiated the theoretical considerations as regards the effect of changes in intensity on the apparent frequency characteristic, and that considerable improvement is obtained with the acoustically compensated volume control. There are, of course, a number of other psychological factors which enter the picture, such as the fact that complex tones rather than pure tones are being listened to and that the ear is not a linear receiving device, which complicate the result and keep the low intensity sound from sounding exactly like that reproduced at the higher intensities. Nevertheless, the improvement is so substantial, that the pleasure obtained in listening to radio and phonograph reproduction at low volumes is increased many times.

electronics

McGraw-Hill Publishing Company, Inc.
330 West 42d Street
New York City

O. H. CALDWELL, *Editor*

Volume VI — FEBRUARY, 1933 — Number 2

"Unremitting effort and research"

THOSE were inspiring words uttered by Alfred P. Sloan, Jr., president of General Motors, as he traced the policy of his company with respect to scientific research during 1932.

"In a year of economic and financial depression General Motors has not only maintained its standards of value and quality, but has introduced new inventions and discoveries resulting from unremitting effort and ingenuity of its research and engineering staffs," said he, and continued. "The inevitable progress and momentum of America go on in spite of depressions, and the large corporations which play so great a part in shaping America's civilization recognize their moral obligation to allow no lag due to adverse conditions to retard their scientific advance."

The status of research in the radio field has not been equally fortunate these last few years. May the example of the older and more successful automotive industry serve to restore executive confidence in research in radio.

New musical piquancies

THE success of the recent experiment by Capt. Taylor Branson, leader of the United States Marine Band, in Washington, D. C., shows the possibility of combining brasses with many gentler solo instruments to give new piquancy to radio music.

With the aid of NBC engineers, Captain Branson achieved an almost perfect tonal balance between the piano and his military band, which numbers 100 pieces. It was the first time the Marine Band has ever broadcast using the piano as a solo instrument.

Helen Corbin Heinl, Washington pianist, was the soloist. She played such selections as Beethoven's "Moonlight Sonata," and Liszt's "Liebestraum" no louder than she would have played them alone, and without the slightest forcing of the tones.

The achievement was heard over a coast-to-coast network. Listeners report that the piano stood out as clearly as if accompanied by a symphony orchestra.

The "Giant Violin," by which an ordinary Stradivarius is amplified a thousand or ten thousand times, and then combined with a brass band, is another experiment along this line, soon to be broadcast.

Other possibilities suggested by the resourceful and open-minded Dr. Stokowski, include similar amplification of the flute, cello, glockenspiel, xylophone and celesta.

"Electrostatic engineering"

DR. KARL COMPTON, of Massachusetts Institute of Technology, did well to coin a new phrase "electrostatic engineering" as defining the new technique that is rapidly being built up employing electrostatic rather than the electromagnetic effects that have concerned electrical engineers almost wholly so far.

Many examples of this new "electrostatic engineering" are already in evidence. The 15,000,000-volt electrostatic generator now nearing completion at South Dartmouth, Mass., may wring new secrets from the atom and from the X-ray spectrum. Piezo-crystals are now being used as relays by direct mechanical action on contacts, providing relays that "hold in" with no current expenditure, merely shelf-loss battery charge. Condenser microphones are already familiar; condenser loudspeakers may yet fulfill the promise they inspire. Radio condensers are revising small-motor design.

Electrostatic electricity was the cynosure of Benjamin Franklin's day. It seems destined to a new ascendancy 150 years later, in the post-depression 1930's.

Four possibilities for cosmic rays

THE newspaper public has been treated to accounts detailing two opposing theories to explain the cosmic radiations that pour in upon us from space, as presented by Dr. Millikan and Dr. Arthur Compton. But these two theories do not exhaust the list of possibilities, for there are at least four reasonable hypotheses which later investigation brings to light. These suggest that cosmic rays may be—

- Electro-magnetic waves of enormously high-frequency, the "birth-cries" of atoms being born in inter-steller space. (Millikan.)
- Electrons of high energy and velocity, comparable to 1,000,000,000 volts. (Compton.)
- Neutrons, or pairs of positively and negatively charged particles travelling with great velocity.
- Combinations of all of the above-mentioned radiations.

As new electron-tube detectors are developed to indicate and measure cosmic rays, we learn more about this baffling mystery of inter-space. And out of such pure philosophical studies may come new light on commercial electronics as well.

Forbidding short-wave sets on autos

ALREADY several cities have police ordinances forbidding the use of short-wave radio sets on any automobile, unless authorized by the local officials. The purpose of course, is to prevent criminals from equipping their own cars with receivers that will let them listen in on the warnings sounded against them. Now a bill is before Congress imposing similar restrictions against all automobile receivers which can pick up police signals. Enactment of this amendment to the Radio Act would permit only police cars to be equipped with short-wave receivers.

While the purpose of these ordinances is commendable, their practical result will be to hinder criminals little or not at all, while becoming an intolerable nuisance to law-abiding citizens who may want to utilize short-waves in the future. We urge the repeal of all such short-sighted, restrictive laws.

NEWS NOTES

X-rays ionize at 100 ft.—Dr. J. W. M. DuMond has been able to use a small X-ray tube to ionize an electroscope 100 ft. distant. Speaking at the California Institute of Technology, he suggested this ionizing action might be employed in war to short-circuit airplane engines, and so wreck attacking planes.

Motion picture engineers at New York April 24-28—The regular semi-annual meeting of the Society of Motion Picture Engineers will be held at the Pennsylvania Hotel, New York, April 24 to 28. W. C. Kunzman, of Cleveland, is chairman of the convention committee. O. M. Glunt, chairman of the papers committee, promises a meeting of unusual interest.

Dr. A. N. Goldsmith has resigned as vice-president and general engineer of the Radio Corporation of America to set up a consulting engineering practice with RCA as one of his clients. Dr. Goldsmith will continue his offices at 570 Lexington Ave., New York City, and will concentrate on radio, electrical entertainment, and acoustic and optical equipment and processes.

L. G. Pacent has organized a private consulting engineering firm with offices at 79 Madison Ave., New York City, and laboratories at Little Neck, Long Island., to specialize in the electrical radio, sound, electronic and motion-picture fields. Mr. Pacent will continue as president of Pacent Electric Company, but will devote most of his time to the new Pacent Engineering Corporation.

Exhibit of art in industry—Radio manufacturers interested in more attractive designs for receiver cabinets, will find stimulating suggestions in the collection of new designs and new materials for other industrial products, arranged by the National Alliance of Art and Industry in the Art Center, 65 West 56th St., New York City, which will continue open until Feb. 15. Alon Bement is director.

Broadcast over mercury-lamp beam—Under direction of E. K. Cohan, technical director, the Columbia Broadcasting System broadcast a program of musical numbers over the modulated beam from a Myers mercury-vapor induction-type lamp, located in the Chrysler Tower, New York. The modulated beam was picked up at the Columbia studios, half a mile away, and produced music of such excellent quality, that little or no difference could be noted between the light-beam and the usual telephone pair.

COUNTING LIBRARY READERS

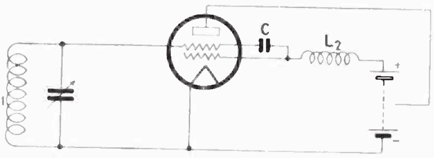
A photo-electric counter now keeps track of the 10,000 readers daily entering the 42d St. door of the New York Public Library. A human counter missed 200 to 300 a day

REVIEW OF ELECTRONIC LITERATURE

HERE AND ABROAD

Stabilization of oscillators

[Bruzau] A method is described by which the frequency of a low-power oscillator can be made practically independent of the voltages applied to the elements of the tube. A double-grid tube is used. The theory is discussed and various stabilizing circuits described, among which that of the figure is preferred—C is about 100 $\mu\mu$ $F.$, L_2 has about one quarter the inductance of L_1. No coupling must exist between these



two coils. Other methods of stabilizing this circuit (a resistance in series with the tuning condenser, the division of L_1 into two parts, one placed as now, the other in series with this condenser with no coupling existing between the two parts) are also discussed and experimental results given.—*L'Onde Electrique, Paris, September (published December 5) 1932.*

✦

Typical European Radio Stations

[Michel Adam]—Four of the most modern European emitters are Prague (120 kw.) Sottens (25 kw.), and Beromunster (60 kw.), both in Switzerland, and Westerglen (50 kw.) in Scotland. At Prague the microphone currents covering the range from 30 to 10,000 cycles are evenly amplified. The modulation may reach 100 per cent. The modulated current is amplified in two stages, the first stage comprising two 40-kw., 20,000 volt units symmetrically mounted, the second, twelve smaller tubes coupled to the first stage by means of a tuned circuit made up of silvered copper tubing held in the grooves of pyrex mandrils. The circuits are tuned by rotating a short-circuited coil placed inside the tuning coils. The power of the station can be cut in half by using only three of the six lamps in each symmetrical half of the second stage.

The Beromunster station which has to serve much mountainous territory is erected above an extended ground water surface. The antenna ground consists of two large circles of copper 15 and 30 m. in diameter with cables running along the diameters from one circle to the other, the total length of the buried conductors measuring 6,000 meters. Plate potential is obtained from a 270 kw. mercury arc rectifier.

The emitter in Scotland is connected to London by means of a cable 400 miles long.—*Revue gen. de l'Electricité 32: 771-779. 1932.*

✦

Recording on magnetic tape

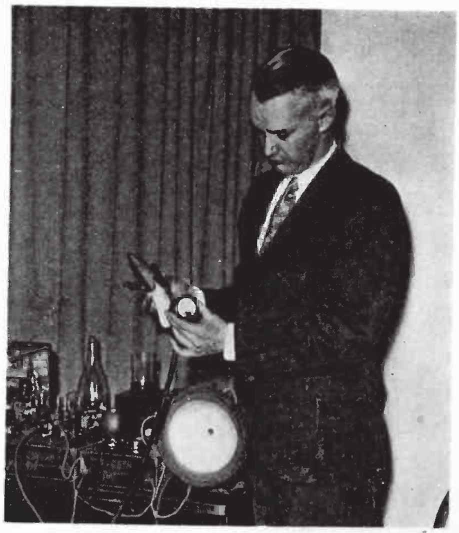
[E. Meyer and E. Schüller, Heinr. Hertz Institute]—Steel tapes 10 to 15 m. long, 0.08 to 0.05 mm. thick, 3 mm. wide (see *Electronics,* May, 1931), proposed by Poulsen in 1900, now find practical application thanks to the combination with electronic amplifiers (Siemens and Halske). Air coils or coils with cores of silicon iron are used for recording; the voice coils have cores of permalloy. The factors influencing response at different frequencies are studied in detail.—*Zeits. techn. Physik. 13: 593-599. 1932.*

✦

Constant-amplitude oscillator

[F. Below, Berlin.] In the Loftin-White oscillator a large common capacity C and a mutual inductance L are used as coupling elements to get constant amplitude when the frequency f must be varied. The sum $6.28\ fL + 1/6.28\ fC$ or the regeneration, remains constant over a certain range. To determine this domain it is necessary to take into account that the resistance R introduced in the grid circuit increases with the square of the frequency according to the formula $R + 4\pi^2 f^2 k$. In order to start oscillations with the same amount of coupling at different frequencies, C must be very large and R very small. L is then given by $-ML_2/2 + (M^2L_2^2 - kR_i)^{1/2}$ where R_i is the tube resistance and L_2 the tuning coil.—*Hochfr. u. El. Ak. 40: 167-169. 1932.*

THE ELECTRIC TONGUE



Utilizing a sensitive millivoltmeter Mr. R. C. Hitchcock measures the voltages produced by various fruits and liquids

✦

Electrons in luminous discharge tubes

[M. J. Druyvesteyn, Phys. Lab. Philips' Eindhoven]—In a sodium vapor lamp (vapor pressure 0.005 mm. mercury) giving 30 candles per watt or 75 per cent of the possible efficiency, 25 per cent of the energy furnished is lost due to positive ions drifting toward the glass walls (3 to 4 cm. wide) and becoming neutralized. The current used was 0.2 to 3 amp. In neon too, the electrons travel in the direction of the positive electrode, whereas most of the positive ions diffuse to the wall. Besides the Dutch sodium-lighted highway (*Electronics,* August, 1932), sodium lamps have now also been installed near Zurich (Switzerland) and near London (England) on a road previously the scene of many accidents.—*Phys. Zeits. 33: 822-823. 856-863. 1932.*

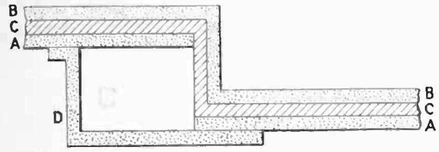
✦

Grid-controlled mercury vapor tubes

[A. Glaser] German General Electric Company (A.E.G.). After having recalled that in commercial thyratrons for 0.5 or 1,000 amp. the time required for starting the main discharge is of the order of 10^{-4} sec., and that an interruption of the plate current for 10^{-4} sec. gives back to the grid its power of controlling the passage of the arc, the influence of frequency, vapor pressure and the size of the hole in the grid electrode upon the grid potential required for starting the discharge is discussed. The higher the anode potential, the lower of course the grid voltage at which the main discharge starts, and for very low plate voltages, rapidly increasing positive grid voltages are necessary. The larger the hole the more marked the influence of the plate; at a certain size of the hole, three different grid potentials may be found at which the arc starts; for still smaller holes the grid versus plate voltage curve lies entirely in the region of positive potentials.—*Zeitz f. techn. Physik 13:549-558. November, 1932.*

Radio patents

[Lg] German 539778. To make small variations in the inductance of one lead of a symmetrical circuit such an arrangement as that shown is used,



where *A*, *B* are the two conductors, *C* an insulator, *D* a bridge completing *A* and which can be moved to alter its inductance. — *Funk, Berlin, December 2, 1932.*

✦

X-ray photography of indirectly-heated tubes

[G. Déjardin and J. F. Thovert, University of Lyons]—The nickel wire upon which the oxides of alkaline earths are deposited must be separated by quartz or magnesia from the hair-pin shaped tungsten wire which supplies the heat. Or the hair-pin shaped tungsten may be dipped into solutions (for instance, alumina with sodium silicate, aluminum nitrate with silica) and heated. The correct spacing may be tested with the aid of a 60 kv. X-ray outfit before the structure is placed into the lamp, and a 100 kv. outfit when it is inside the lamp and surrounded by metallic surfaces. When lead-glass is used a Coolidge tube may become necessary (100 to 120 kv., a few milliamp., 30 seconds exposure). See also *Electronics,* October, 1930—*Journal de physique 3: 159S. 1932. Revue gen. Electricité 32: 814. 1932.*

Piezo-electric properties of Rochelle salt

[E. Schwartz, University of Hamburg.] In contrast to quartz crystals for which the piezo-electric effect is proportional to the pressure applied, the charges appearing on the most sensitive surfaces of a Rochelle salt crystal increase more rapidly than the pressure. A charge of 14.3 micro e.s.u. per dyne is obtained when a load of 3 kg. is applied as against 0.06 per dyne for quartz. Another complication is that the dielectric constant varies not only with the temperature, but also with the electric field produced by the charges on the surfaces. Excepting the least sensitive direction *c* it has abnormally high values (2,000 to 6,000 against 80 for water). The author thinks that by cutting sections perpendicular to the axis *c* of the prisms he will obtain material suitable for microphones (see also *Electronics,* May 1932 on piezo-electric loudspeakers).—*E.N.T. 9: 481-495. 1932.*

✦

Sound ornaments

[Gradenitz] Details with good photographs of the ornamental forms which Fischinger has found to give certain musical effects when traced on film and fed to a normal sound projector: for example, a note with its octave, third, and fifth, the contrast between heavy and massive tones, and light, diffused ones; and especially the geometrical ornaments which give the timbres of bassoon, flute, xylophone, etc. [Article of considerable importance as a step towards the *direct* production of music from films]—*La Nature, Paris, November 15, 1932.*

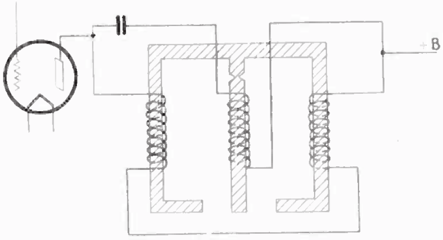
Results of the Madrid Conference

[H. Giess, President of the German Delegation]—The waves for broadcasting purposes have been agreed upon as 1875 to 1131 m. or 160 to 265 kc., and 545 to 200 m. or 550 to 1500 kc. to the exclusion of 1364 kc. (220 m.). The different countries have to settle the distribution of these waves. The 600 representatives of 80 states and 85 societies have signed an agreement creating an international union of telecommunication embracing telegraphy, telephony and radio.—*Funk Bastler, December 23, 1932.*

✦

New loudspeaker system

[Noack] Borchardt has developed a system using soft iron laminated field-magnets and armature, the latter being fixed flexibly to the neutral point of the former. The first coils (about 400 ohms) are to be connected between the last anode and + *B*, and take only about ½ watt. They act as an effective choke for the audio frequencies. The armature coil is connected through a condenser, as shown in the figure.—*Funk Magazin, Berlin, December, 1932.*



✦ ✦ ✦

New amplifiers—detectors and oscillators

[*Continued from page 35*]

the tube will deliver 50 ma. of current at an r.m.s. voltage per plate of 225. The tube is a full-wave rectifier.

The 25Z5 is aimed at the universal receiver. It is a full-wave rectifier with separate connections brought out for each cathode terminal. Thus the tube can be employed as a half-wave rectifier or, what is more interesting, as a voltage doubler. Thus in the cheaper sets the 110-volt input from the line may be doubled without the aid of a transformer. As a half-wave rectifier the output current is approximately doubled compared to a less complicated structure. With 16 µf. condensers in the double circuit the voltage output is 180 volts at a current drain of 100 ma. and at 20 ma. the voltage is about 250 volts.

RECTIFIERS

			Cathode				
Type	Purpose	Bulb	Type	Volts	Amps.	A.C. voltage per plate (r.m.s.)	D.C. output current ma.
84	Auto radio, B-power	ST-12	Heater	6.3	0.5	225	50
96	Half wave, Mercury	S-12	Heater	10.0	0.3	350	100 ave.
98	Full wave, Mercury	S-12	Heater	6.3	0.5	350	50 ave.
5Z3	High vacuum full-wave	ST-16	Filament	5	3.0	500	250
25Z5	Rectifier, Voltage doubler	ST-12	Heater	25	0.3	125	100
ER-1	Vacuum, Half-wave	ST-12	Heater	6.3	0.3	250	50
HZ-50	Half-wave, high vacuum	...	Heater	12.6	0.3	125	....

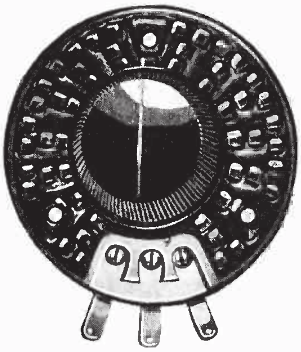
There are two possibilities for the combined detector-oscillator socket. One is a 5-grid tube having some of the characteristics of the Dow electron coupled oscillator discussed in the technical literature and widely used by amateurs and others. The other possibility is a pentode-triode. The characteristics of these tubes had not been definitely decided at the time of writing.

+ NEW PRODUCTS

THE MANUFACTURERS OFFER

Rheostat

The Ward Leonard Electric Company, Mount Vernon, N. Y., offers a new design of Adjustat rheostat in which the "dead shaft" construction is completely insulated from current carrying parts, and simplifies single hole mounting on steel panels without the use of troublesome insulating bushings or washers.



A $2\frac{3}{4}$ in. circular refractory plate forms the base for the special resistance wire of low temperature coefficient of resistivity. The plate, wire, contacts and terminal connections are thoroughly protected against corrosion and damage by fused-on vitreous enamel.

The adjustat is regularly furnished from 1 to 25,000 ohms. It will dissipate 30 watts continuously with a temperature rise not exceeding 250 deg. C. Sixteen steps of control are provided, and terminals are arranged for potentiometer connection.—*Electronics, February, 1933.*

✦

Automobile spark-suppressor

The Globar Corporation, Niagara Falls, N. Y., announces a new automobile radio spark-suppressor for dampening the oscillations in automobile ignition circuits.

The disadvantage of intermediate contact between the resistor and its terminals has been eliminated in the construction of this suppressor, through the use of a high-fired resistance body to which the terminals are directly attached by a process which constitutes virtually a weld. The exposed metal parts necessary for attaching the suppressor to the spark plug and cable, are confined to the ends of the resistor, thereby reducing exposed metal surfaces to absolute minimum.

This suppressor can be furnished in three types, spark-plug, distributor, and splice-in.—*Electronics, February, 1933.*

Photoelectric controller

The Westinghouse "Photo-Troller" is a rugged industrial device which can be actuated by a phototube or by delicate contacts carrying only a few microamperes, and is specially adapted to applications such as counting, limit switches, door opening, automatic weighing, etc.

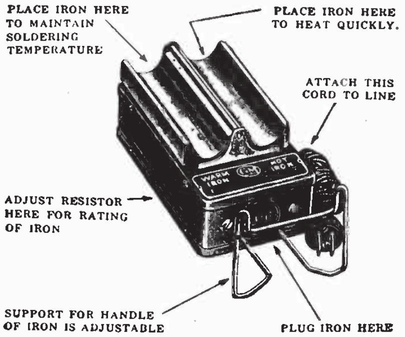
The phototube or sensitive contact operates a sturdy grid-glow tube directly which in turn closes a contactor capable of initiating any desired operation. Thus, delicate intermediate relays are eliminated and great reliability is obtained. Photo-Troller is assembled in a sheet metal cabinet with convenient door and knockouts. Units are available for any commercial voltage or frequency except d.c. Various light sources are available to operate at distances up to 22 feet from the phototube.

Auxiliary devices are available for use with the Photo-Troller which adapt it to a large number of unusual machine and process applications.—*Electronics, February, 1933.*

✦

Soldering-iron stand

G-M Laboratories, Inc., 1735 Belmont Ave., Chicago, have announced a new type of soldering-iron stand that effects a saving of 30 to 40 per cent in power consumption and overcomes many of the principal soldering troubles. The most serious difficulties in soldering work result from an overheated, dirty iron, and much defective soldering results from the tip of the iron becoming pitted and corroded from excessive heat. The new stand has two cradles. When placed in the left-hand cradle the iron receives only sufficient current to keep it at the minimum and yet proper soldering temperature for immediate use. The result is a material saving of power and greatly increased life of the heating element.—*Electronics, February, 1933.*


PLACE IRON HERE TO MAINTAIN SOLDERING TEMPERATURE
PLACE IRON HERE TO HEAT QUICKLY.
ATTACH THIS CORD TO LINE
WARM IRON
HOT IRON
ADJUST RESISTOR HERE FOR RATING OF IRON
SUPPORT FOR HANDLE OF IRON IS ADJUSTABLE
PLUG IRON HERE

Grip-connectors

To meeting the demands of the experimenter, engineer and amateur radio fan, the Littelfuse Laboratories, 1772 Wilson Ave., Chicago, Ill., have designed a connector which may be slipped directly on the fuse ends. It has a thumbscrew for securing the wire, thus providing a fused circuit without the trouble of soldering to a mounting block. The connector grips the fuse cap snugly and the whole assembly hangs directly in the line.—*Electronics, February, 1933.*

✦

Heat-resistant insulated wire

Vega refractory (Chromoxide) insulated wire consists of copper wire having a refractory *heat resistant* coating comprised chiefly of inorganic material (as contrasted with organic coatings of other insulations) which is reacted integral to and baked on the surface of the wire. The insulation is a refractory chromium compound which is produced by the reaction of chromium oxide and an inorganic binding material applied to the wire at a high heat in combination with a water-insoluble organic binding material which is used for structural purposes.

The insulation is thin and flexible, having a space factor comparable to enameled wire, thus allowing a large number of turns in a small space when compared with other refractory insulations, as asbestos.

The insulation has high thermal conductivity. Its attractive green color is characteristic of the materials used and cannot burn out. The coating is in uniform thickness and will withstand handling.

Coils wound with Vega wire will withstand continuous operation at high temperature limits, without short-circuiting between turns, the manufacturers specifying that the insulation shall withstand continuous operation at Class B (A.I.E.E. Standards) temperature as contrasted with Class A (enamel, cotton or silk) insulation.

A feature of the insulation is its adaptability with flat type conductors. In the United States this development is covered by Ruben patents Nos. 1,896,040; 1,896,041; 1,896,042; 1,896,043 and pending applications. Vega wire is manufactured and sold by American Enameled Magnet Wire Company of Port Huron, Mich. — *Electronics, February, 1933.*

High-efficiency B eliminator

A NEW B ELIMINATOR for automobile radios has been announced by P. R. Mallory & Co. In this device instead of a tube rectifier, a vibrating reed operating in synchronism with the interrupter performs the rectification function. A single magnet supplies the power. This arrangement overcomes the power losses occuring in the rectifier tubes and yields an efficiency of 60 per cent. Five types are available depending upon the current output required. At 6.6 volts the type 10 with an output voltage of 200 at current drains of 40-45 ma. requires 2.1 amperes from the battery with a rated output of 8.4 watts.

The new eliminator weighs 9 lbs. The dimensions are $2\frac{11}{32}$ in. by $6\frac{11}{16}$ in. by $7\frac{3}{16}$ in. The small size enables it to be built-in to the radio set if desired. Models have been designed for 12 and 32 volt operation. The output voltage varies little with changes in current and therefore the unit can be used with class B amplification systems. A model is provided in a metal case together with a dynamic speaker for manufacturers requiring the utmost saving in space and weight.—*Electronics, February, 1933.*

◆

B power supply

THE CARTER GENEMOTOR CORPORATION, 361-365 W. Superior St., Chicago, has developed the new Carter Genemotor B power supply equipment for replacing B batteries in all kinds of radio sets, amplifiers, etc.

The new Carter 32-volt B power supply is finding a large market in rural sections. It is claimed that more than 700,000 32-volt farm light plants are in use and that a battery-operated radio set using B batteries is connected to each plant. The Carter B power supply eliminates B battery expense. There is a Carter B power supply unit for use with battery sets where no light current is available.—*Electronics, February, 1933.*

◆

Infra-red photo relay

THE ARGUS PHOTO RELAY is designed for operation on alternating or direct current supply mains and incorporates features that absolutely assure dependable and continued operation under all conceivable conditions, whether they be indoors or outdoors, stationary or mobile, high temperature, or extremely wet.

The photo-relay is housed in a machined aluminum casting. The "Unilet" is secured to the relay by means of water-proof flexible metal tubing, and the entire assembly is absolutely waterproof. Cork gaskets between the upper and lower halves will permit operation of this unit over a long period of time entirely submerged in water. The entire assembly is rigidly mounted to a bakelite panel which permits easy access for adjustment. A jack is also provided to permit reading the plate current of the amplifying tube with an external milliammeter.

A calibrated light-admittance tube is provided when the relay is to be used with the beam projector in all daylight applications, such as traffic or pedestrian counting, drinking fountain control, and the opening of garage doors by means of headlights.

The projector is of the focusing type and is designed to produce a powerful concentrated beam of light and will be found suitable for operating the relay over great distances such as a wide highway, boulevard or race track. The regular model may also be fitted with a special filter that eliminates all the visible portion of the beam, leaving only the infra-red. The resulting beam is effective up to a distance of 50 feet. This invisible beam, or ray, focused on the photo-relay makes an excellent burglar alarm. Infra-red projectors are also available that are effective up to distances of 300 feet, upon special order to the makers, the Argus Electric Company, St. Charles, Ill.—*Electronics, February, 1933.*

◆

Midget "Megger" tester

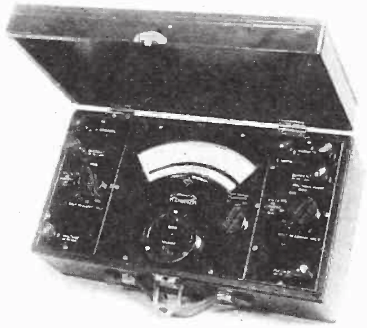
A NEW MIDGET "MEGGER" TESTER is being offered by the James G. Biddle Co., Philadelphia, as an important addition to its group of "Megger" insulation testing sets.

The distinguishing characteristics of this instrument are its small size and weight, which have been reduced to almost pocket dimensions,—$5\frac{3}{4}$ in. by 4 by $2\frac{3}{8}$ in.—and the weight is only 3 lb.

In common with other Megger instruments, the Midget tester consists of a true ohmmeter, direct-reading like a voltmeter, combined with a special d.c. hand generator. The scale reads as high as 20 megohms and the generator supplies testing current at 500 volts, thus obviating necessity for depending on batteries or any other outside source of current.—*Electronics, February, 1933.*

Multi-range meter

THE SENSITIVE RESEARCH INSTRUMENT CORPORATION of 4545 Bronx Blvd., New York City, announces a new 27 range Universal a-c and d-c Polyrange instrument, having distinct advantages over old designs. It has 13 ranges in direct current reading from 0.00002 volt up to 1,000 volts with a resistance of 5,000 ohms per volt and in current from 0.000002 ampere up to one ampere. The accuracy of these ranges is one-fourth of 1 per cent.



By turning a single knob, the meter becomes a 14 range a-c instrument, covering all frequencies up to 5,000 cycles with an accuracy of one-half of 1 per cent. It measures current from 0.002 ampere to 3 amperes and in voltage from 0.06 volt to 1,000 volts, resistance 100 ohms per volt.

The instrument is so designed that if the a-c side should be inadvertently burned out, the meter can still be used as a d-c meter until such time as is convenient to have it repaired. This instrument covers almost all of the meter measurements needed in the laboratory.—*Electronics, February, 1933.*

◆

Prismatic derivator

IN STUDYING THE OPERATION of electrical instruments and apparatus, as well as all kinds of radio tubes, characteristics have frequently to be interpreted graphically. The methods which have been used so far for this purpose, have as a whole not been very satisfactory, owing to the human element being too great a source of error. To aid in this work, a new tool, the Askania prismatic derivator, employs a small prism which when placed over the curve to be interpreted makes it possible, by optical magnification, to determine accurately tangents and normals to mathematical curves. The easy and rather foolproof operation of the instrument without particular care or practice, makes it a useful tool for engineering departments of industrial plants, laboratories, technical schools and other institutions. The instrument is furnished by American Askania Corporation at Houston, Texas, and Chicago, Ill.—*Electronics, February, 1933.*

U. S. PATENTS

IN THE FIELD OF ELECTRONICS

Radio and Communication Circuits

Differential volume control. Diversity receiving system comprising several antennas having different fading characteristics, amplifiers coupled to each antenna and means for making a change over from one signal to another more stable and less noticeable. H. H. Beverage assigned to R. C. A. Filed December 11, 1928. No. 1,888,065.

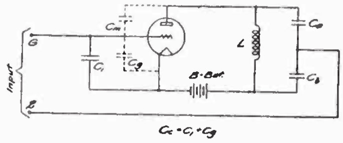
Radio receiving system. A series of resonant circuits coupling two tubes together and forming therewith a filter having the characteristic of a low-pass filter for frequencies higher than the desired frequency. J. M. Miller assigned to Atwater Kent Mfg. Co. Filed Sept. 27, 1930. No. 1,888,430.

Tuned receiver tube. Two triodes in a single envelope and coupled together by piezo-electric crystals so that the second tube responds only to a predetermined frequency. Siegmund Loewe, assigned to R. C. A. No. 1,875,059.

Discharge tube. A cold tube arranged to actuate a potentially controlled relay system. A. M. Skellett, assigned to W. E. & M. Co. No. 1,877,607.

Power Circuits Amplification, Etc.

Reducing reaction. A tube with input and output circuits in a Wheatstone bridge arrangement to suppress oscillations of the tube. Stuart Ballantine, assigned to R.C.A. Filed July 14, 1925. No. 1,889,741.



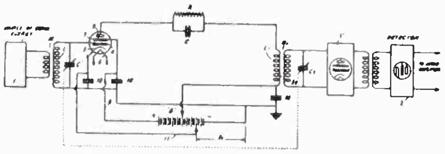
Photocell compensating system. Method of recording by means of a shutter, etc., several longitudinal recordings on a single film. G. B. Scheibell, Newark, N. J. Filed August 1, 1930. No. 1,886,125.

Push-pull amplifier. In series with a normal steady bias to a push-pull amplifier is a resistance shunted by a condenser. When an appreciable amount of grid current flows, the bias to the tube is increased by the drop across this resistance. Eugene Peterson, assigned to B. T. L., Inc. Filed June 20, 1928. No. 1,893,302.

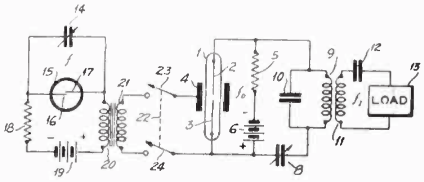
Wired radio. Method of receiving wired radio signals on a space radio receiver. R. D. Duncan, Jr., assigned to Wired Radio, Inc. No. 1,892,696.

Push-pull system. A coupling device to connect a driver and a push-pull amplifier in which the secondary winding has an impedance lower than the input impedance of the driven stage when the grid of this stage becomes positive. J. O. Baker, assigned to G. E. Co. Filed Oct. 20, 1931. No. 1,890,489.

Dynatron amplifier. Combination with a dynatron, a tunable resonant network whose impedance at resonance varies with the frequencies to which the network is tuned and means in series between the tube anode and the network in the output circuit for maintaining the total impedance of the output circuit constant during tuning. P. O. Farnham, assigned to R.C.A. Filed Oct. 17, 1931. No. 1,890,503.

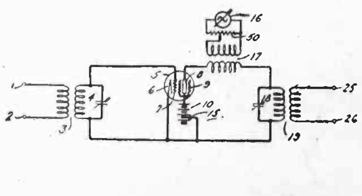


Relaxation circuit. Relaxation oscillator for recurrently energizing the oscillation circuit at a frequency which is an aliquot part of the desired frequency, said circuit including a glow discharge tube having an external control electrode, a resistance and a source of direct current in series. Another relaxation oscillation circuit including a similar tube acts as demodulator. August Hund, assigned to Wired Radio, Inc. Filed Oct. 1, 1931. No. 1,893,029.



High-gain amplifier. A system for obtaining current amplification upward of 1,000,000 by negatively biasing the grid of the tube to such an extent that the positive ion current is predominant and using a resistance for the grid circuit having a magnitude of 1,000 megohms or above. Joseph Razek and P. J. Mulder, Drexel Hill, Pa. Filed Dec. 22, 1930. No. 1,890,750.

Pentode circuit. Plate of the tube is essentially at the same potential as the cathode, while the screen grid has a positive potential. The a.c. is supplied to the anode and means is provided for adjusting the intensity of the a.c. whereby the ratio of useful current to noise producing current is increased. F. C. Llewellyn, assigned to B. T. L., Inc. Filed April 12, 1930. No. 1,893,031.



Electronic Applications

Fire control. A light-sensitive cell subjected to rays from a burning film and an electro-mechanical means acting upon the inflammation of the film. W. H. Dewitt. Filed May 5, 1931. No. 1,890,804.

Power conversion. Method of connecting a d.c. supply circuit to an a.c. load device. A. S. Fitz Gerald, assigned to G. E. Co. Filed May 12, 1931. No. 1,891,084.

Remote control system. Apparatus for determining and equalizing differences in the positions of two shafts located at a distance apart. J. Vopel and Rudolph Oetker, Berlin, Germany. Filed June 6, 1931. No. 1,890,891.

Timing device. Combination of a power supply, a translating device and electron tube and means for impressing upon the control electrode a potential rendering the tube conductive to effect completion of the circuit of the time dividing device. C. Stansbury and G. C. Brown, assigned to Cutler-Hammer, Inc. Filed Dec. 10, 1931. No. 1,892,017.

Power conversion. A d.c. supply circuit with several resonant circuits, each including a capacitor, a pair of tubes, and a discharging circuit. F. W. Frink, assigned to G. E. Co. No. 1,891,924. Filed Nov. 22, 1930.

Vacuum switch. An evacuated receptacle and a switch mounted therein and means for operating the contacts from without. D. C. Prince, assigned to G. E. Co. Filed March 23, 1928. No. 1,892,538.

Comparison of the intensity of light rays. A comparison by means of a rotating disk or shutter and a light sensitive cell. F. C. Whalen, London, England. Filed May 22, 1931. No. 1,890,837.

Material sorting machine. Method of actuating power shears to cut off material at a given length. The device uses a three-element tube. W. H. Spire, assigned to Thompson Products, Inc., Cleveland. Filed Sept. 14, 1931. No. 1,883,047.

Gas determination. Apparatus for determining the condition of gas comprising a chamber in which condensation changes the light reflected into a light-sensitive element. M. C. W. Tomlinson, assigned to W. E. Co. Filed Feb. 16, 1929. No. 1,883,116.

Printing telegraph. Patents granted to H. Chireix and H. Goudet, Paris, France, for high speed printing telegraph. No. 1,893,158. And for a high speed multiplex telegraph. No. 1,893,159.

Patent Numbers

The following table gives the numbers of patents issued in the United States since the million-mark was reached. For example patents issued in 1932 bore numbers between 1,787,424 and 1,892,662.

Jan. 1			
1912	1,013,095	1923	1,440,362
1913	1,049,326	1924	1,478,996
1914	1,083,267	1925	1,521,590
1915	1,123,212	1926	1,568,040
1916	1,166,419	1927	1,612,790
1917	1,210,389	1928	1,654,521
1918	1,251,458	1929	1,696,897
1919	1,290,027	1930	1,742,181
1920	1,326,899	1931	1,787,424
1921	1,364,063	1932	1,892,662
1922	1,401,948		

electronics

radio, sound, communications and industrial applications of electron tubes • • • design, engineering, manufacture

Stabilization and statistics

◆

Styling radios for sales appeal

◆

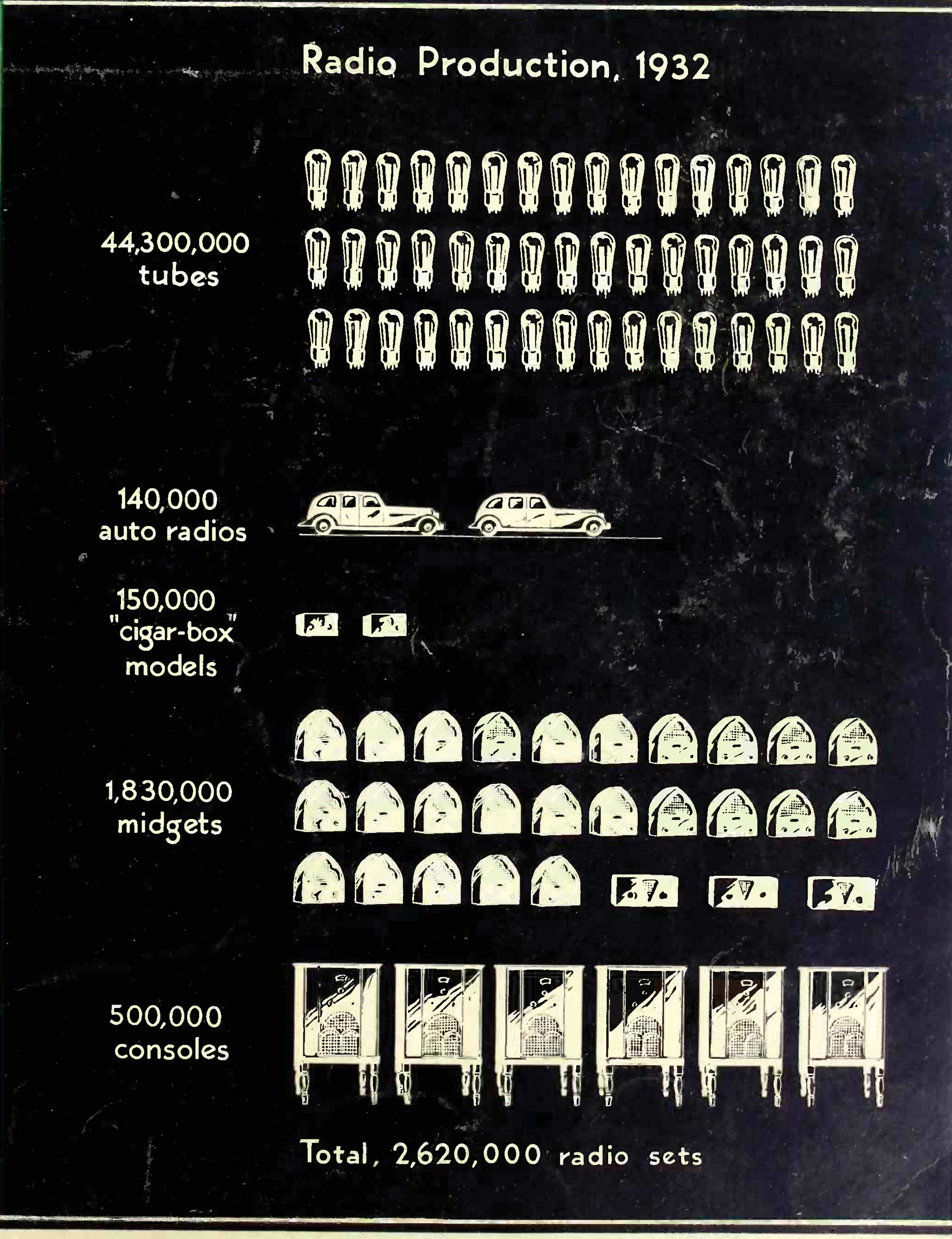
Electron-coupled oscillators

◆

Component price stabilization

◆

The Kathetron—a controlled rectifier



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MARCH, 1933

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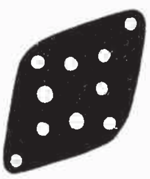

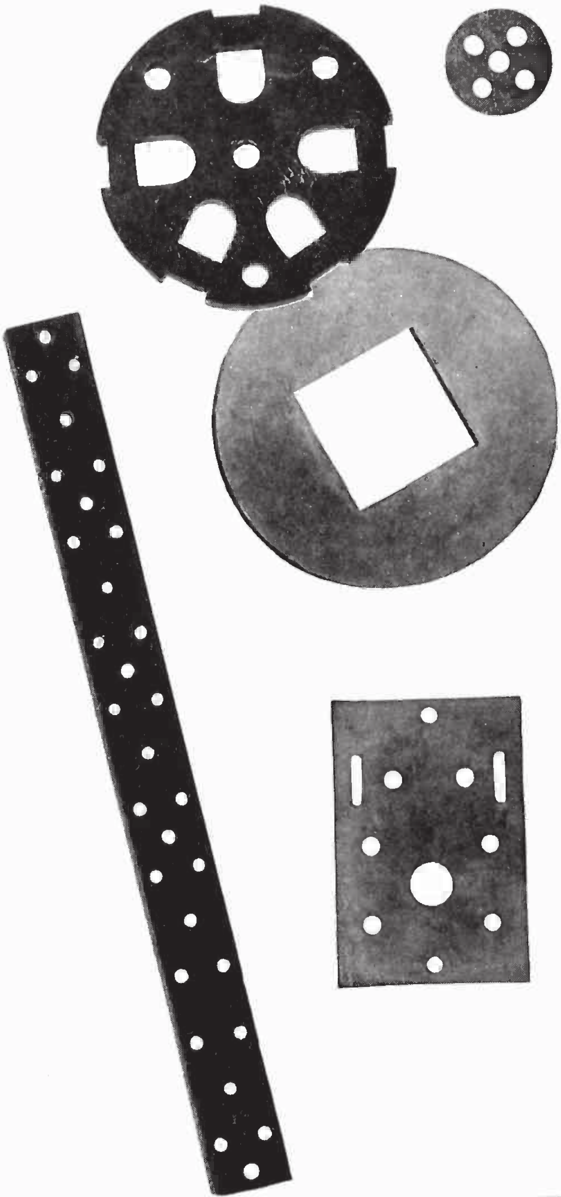

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electronics

O. H. CALDWELL
Editor
KEITH HENNEY
Associate Editor

McGRAW-HILL PUBLISHING COMPANY, INC.

New York, March, 1933

radio
sound pictures
telephony
broadcasting
telegraphy
counting
grading
carrier systems
beam transmission
photo cells
facsimile
electric recording
amplifiers
phonographs
measurements
receivers
therapeutics
traffic control
musical instruments
machine control
television
metering
analysis
aviation
metallurgy
beacons
compasses
automatic processing
crime detection
geophysics

▼

Stabilization— and Profits

THE figures on radio production in this issue of *Electronics* picture the condition that exists in radio today. Reduction in unit values, and the drop in total units sold, both point the need for stabilization. The time has come to get the radio industry onto a sound, profit-making basis.

It can be done. The popular interest in radio is as great or greater than ever. Broadcast programs increase in interest and in importance. The public continues to buy sets, and there are still millions of homes to be equipped or brought up to date.

LEADERSHIP in the job of building back toward stabilization must come from the manufacturing end. Distributors and dealers, of course, need to reform practices that too often spread merchandising destruction and carry down their own businesses in the melee. But changes in the manufacturing set-up are fundamental to any continuing reforms that come in the distribution end.

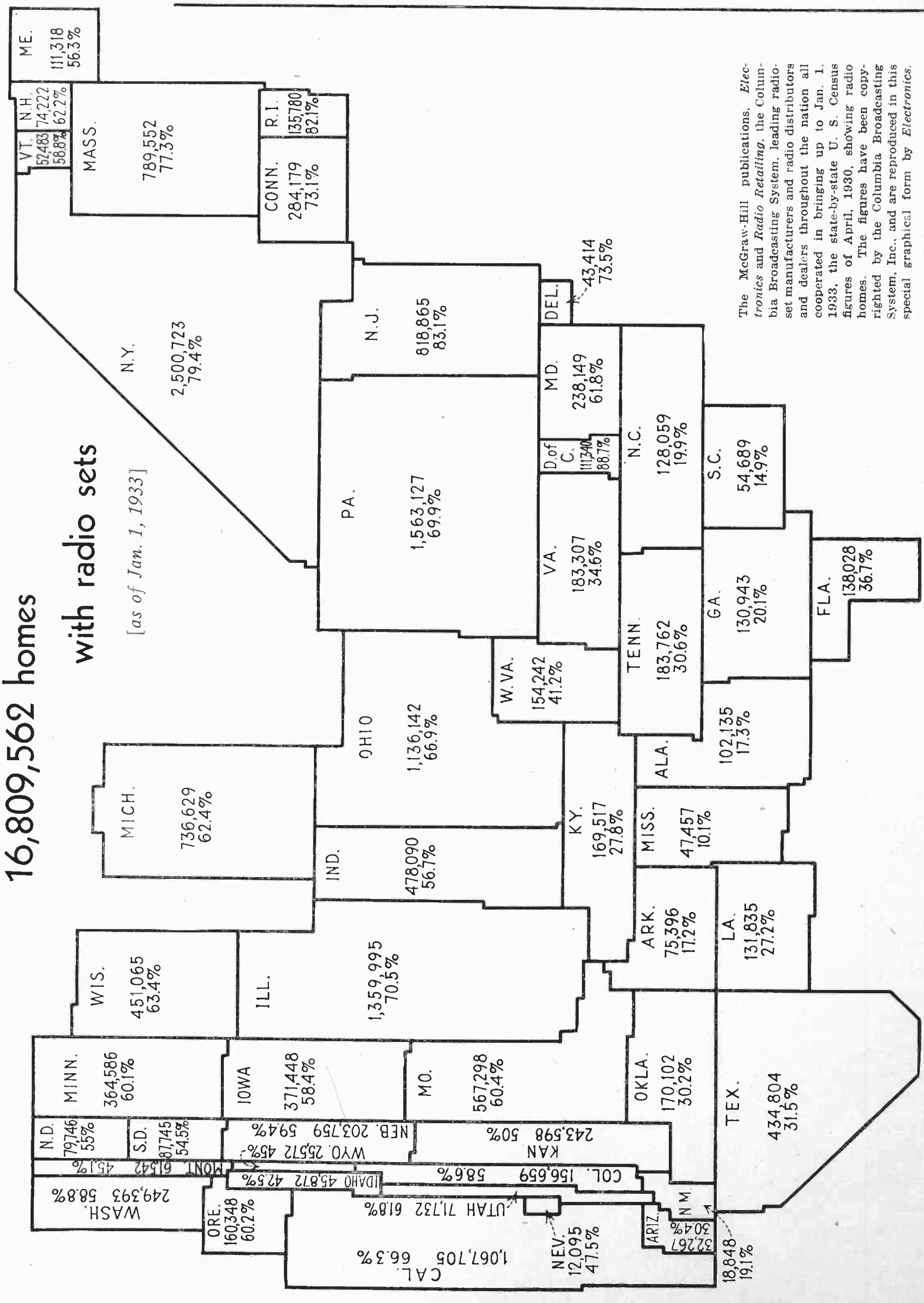
With recent changes in the Radio Manufacturers Association's plan of operation, and with the settlement of the Government's suit against the Radio Corporation, the raw materials seem at hand to get stabilization. Licensing authority is now placed unmistakably in RCA's hands, and should be administered in a way to stimulate a healthy production situation, without destructive surplus. RCA's responsibility is that of leadership and control. Meanwhile the radio producers can help radio's renaissance by suppressing rampant individualism and becoming more group-minded.

EVERY opportunity is now given to the responsible heads of radio manufacture to get together and show the way towards stabilization and profits for the industry.

RADIO STATISTICS—

16,809,562 homes with radio sets

[as of Jan. 1, 1933]



The McGraw-Hill publications, *Electronics* and *Radio Retailing*, the Columbia Broadcasting System, leading radio-set manufacturers and radio distributors and dealers throughout the nation all cooperated in bringing up to Jan. 1, 1933, the state-by-state U. S. Census figures of April, 1930, showing radio homes. The figures have been copyrighted by the Columbia Broadcasting System, Inc., and are reproduced in this special graphical form by *Electronics*.

HOW THE MAP OF THE UNITED STATES WOULD LOOK if the area of each state were proportional to the number of homes in that state having radio sets

PRODUCTION AND USE

(Statistics in this issue are copyrighted but may be quoted providing credit is given Electronics.)

	Total investment United States	Annual gross revenue	Number of employees	Annual payroll
Radio manufacturers,[1] distributors, etc.	**$150,000,000**	....	**[2]70,000**	**$80,000,000**
Broadcasting stations	**$27,000,000**	**$45,000,000**	**9,000**	**$80,000,000**
Listeners' sets (16,800,000 homes)	**$1,600,000,000**	....	......	**[3]$200,000,000**
Commercial radio stations	**$25,000,000**	**$10,000,000**	**15,000**	**$4,000,000**

[1] Radio set manufacturers now number 152. [2] Employees at peak of seasonal employment.

[3] Annual operating expense of listeners' sets, for tube replacements, electricity, batteries, servicing, etc.

1932 Sales: 2,620,000 Sets; 44,300,000 Tubes
Total retail value all radio products, $196,190,000

1926	1927	1928	1929	1930	1931	*1932*	Products
1,750,000	1,350,000	3,281,000	4,438,000	3,827,800	3,420,000	*2,620,000*	Consoles and midget receivers
$200,000,000	$168,750,000	$388,000,000	$592,068,000	$332,198,000	$212,040,000	*$124,860,000*	
$114	$125	$118	$133	$87	$62	*$48*	Aver. retail price per set
30,000,000	41,200,000	50,200,000	69,000,000	52,000,000	53,500,000	*44,300,000*	Tubes
$58,000,000	$67,300,000	$110,250,000	$172,500,000	$119,600,000	$69,550,000	*$48,730,000*	
$1.93	$1.63	$2.20	$2.50	$2.30	$1.30	*$1.10*	Aver. retail price per tube
$80,000,000	$68,000,000	$50,400,000	$30,530,000	$21,514,000	$13,100,000	*$9,500,000*	A-B-C (dry) batteries
$88,000,000	$72,550,000	$63,000,000	$15,950,000	$13,626,000	$8,580,000	*$6,200,000*	Other accessories
$50,000,000	$21,000,000	$12,000,000	$7,500,000	$6,000,000	$6,000,000	*$6,900,000*	Parts (to consumers)
$200,000,000	$168,750,000	$388,000,000	$592,068,000	$336,717,500	$212,040,000	*$124,860,000*	Radio sets
$50,000,000	$21,000,000	$12,000,000	7,500,000	6,000,000	$6,000,000	*$6,900,000*	Parts
$256,000,000	$235,850,000	$290,550,000	242,980,000	158,234,000	$91,230,000	*$64,430,000*	Accessories (incl. tubes)
$506,000,000	$425,600,000	$690,550,000	$842,548,000	$500,951,500	$309,270,000	*$196,190,000*	Total sales for year

Homes in the United States with and without Radio Sets

States Listed Alphabetically	Number of Radio Homes as of January, 1933	Per Cent of Radio Owernship as of January, 1933	Homes Yet Without a Radio Set
Alabama	102,135	17.3	488,000
Arizona	32,267	30.4	74,000
Arkansas	75,396	17.2	362,000
California	1,067,705	66.3	542,000
Colorado	156,659	58.6	111,000
Connecticut	284,179	73.1	104,000
Delaware	43,414	73.5	15,500
Dist. of Columbia	111,340	88.7	14,000
Florida	138,028	36.7	238,000
Georgia	130,943	20.1	520,000
Idaho	45,872	42.5	62,000
Illinois	1,359,995	70.5	569,000
Indiana	478,090	56.7	365,000
Iowa	371,448	58.4	265,000
Kansas	243,598	50.0	243,500
Kentucky	169,517	27.8	440,000
Louisiana	131,835	27.2	352,000
Maine	111,318	56.3	86,500
Maryland	238,149	61.8	147,000
Massachusetts	789,552	77.3	231,000
Michigan	736,629	62.4	445,000
Minnesota	364,586	60.1	242,000
Mississippi	47,457	10.1	423,000
Missouri	567,298	60.4	372,000
Montana	61,542	45.1	75,000
Nebraska	203,759	59.4	139,000
Nevada	12,095	47.5	13,000
New Hampshire	74,222	62.2	45,000
New Jersey	818,865	83.1	166,000
New Mexico	18,848	19.1	79,000
New York	2,500,723	79.4	650,000
North Carolina	128,059	19.9	515,000
North Dakota	79,746	55.0	65,000
Ohio	1,136,142	66.9	562,000
Oklahoma	170,102	30.2	393,000
Oregon	160,348	60.2	106,000
Pennsylvania	1,563,127	69.9	675,000
Rhode Island	135,780	82.1	29,500
South Carolina	54,689	14.9	312,000
South Dakota	87,745	54.5	73,000
Tennessee	183,762	30.6	417,000
Texas	434,804	31.5	945,000
Utah	71,732	61.8	44,000
Vermont	52,483	58.8	37,000
Virginia	183,307	34.6	346,000
Washington	249,393	58.8	175,000
West Virginia	154,242	41.2	220,000
Wisconsin	451,065	63.4	251,000
Wyoming	25,572	45.0	31,000
Total	16,809,562	56.2	13,200,000

When will Radios be STYLED

Present sets still in "Model T" stage

says

WALTER DORWIN TEAGUE

Mr. Teague is consultant on the design of the products of the Corning Glass Works, Eastman Kodak Company, Bausch & Lomb Optical Company, Taylor Instrument Companies, etc. He designed the body of the Marmon Sixteen car, which has had a profound influence on automobile styles in this country. He also designed the Kodak Shop at 745 Fifth Ave., New York City, and has recently completed a series of designs of "Century of Progress" silks for Marshall Field & Co. Among his other clients are Thomas A. Edison, Inc.; National Radiator Corporation, National Carbon Company, General Register Corporation, Square D Company, etc. He has designed many packages and a wide range of products, including pianos, gas boilers, calculating machines, cameras, temperature and weather instruments, optical instruments, furniture and rugs.

NOT so long ago I was asked by the president of a large radio manufacturing corporation to pass judgment, as a matter of courtesy, on two models for radio cabinets. It was an embarrassing moment: at first glance I could not see that either was less bad than the other; both looked exactly like all the radio cabinets I had seen advertised or displayed—that is, both looked like the devil.

Both were designed in that jig-saw school of art which flourished in the General Grant period in architecture, and in furniture survives only in the "Your-Credit-Is-Good-With-Us" instalment houses; both were plastered with imitation carving and loaded with machined mouldings and lathe turnings; and both had some faint reminiscence of a "period" which was an excuse for calling them "Queen Anne" or "Tudor" or what not.

On close comparison I realized that one bore slightly less of this ginger-bread than the other and I was able to give it a feeble preference.

Now this executive, who took these cabinets seriously and believed that their differences would have an effect on sales, was a man of culture and good taste. I am sure that his home is attractively furnished and that he would scorn to give house-room to any piece of furniture in the least like these cabinets. Yet he was too close to his own business and so imbued with his industry's viewpoint that he took it for granted that radio cabinets must look like that; and because his cabinets were well built and because their jig-saw work and imitation carving differed from that on competing lines, he believed his line was distinctive. He saw differences where I am sure, from the buying public's viewpoint, no difference existed.

I am a fairly observing person, especially in matters of design — my business makes me so. And I assure you I know none of the standard lines of radio cabinets which is sufficiently distinctive or superior to be recognizable at sight. It is obvious that they all come out of the same hopper and represent the

National Alliance of Art and Industry to hold clinic on

"How to Style Radio Sets for Increased Sales," March 20

Luncheon meeting, Monday, March 20, 12:30 p.m., at Hotel White, Lexington Ave., at 37th St., New York City.

This meeting will be one of the regular large "clinics" held by the National Alliance for the purpose of promoting cooperation between industry executives and designers. These clinics have been widely attended by industrial leaders in many fields, and have had great influence on subsequent designs in those industries.

The program as planned at the time "Electronics" goes to press, will include brief talks by leading merchants and designers, pointing out the need for styling radio sets, and the possibilities in this field.

Grover Whalen, general manager Wanamaker's, New York City.
Kenneth Collins, formerly with Macy's, now with Gimbel's, New York City.
Henry Dreyfuss, designer, New York. George Sakier, designer, New York.

Richard DeWolfe Brixey is president of the National Alliance, and Alon Bement is director. Its headquarters are located in the Art Center Building, 65 East 56th Street, New York City.

At the request of "Electronics" the National Alliance office has supplied the following alphabetica list of qualified designers who have done work in the fields of various industrial products.

Lucian Bernhard
Norman Bel Geddes
Christoph Castou
Donald Deskey
Henry Dreyfuss
Helen Dryden
Paul Frankl
Hugo Gnam
Lurelle Guild
Vahan Hagopian
W. S. Harrison
Wolfgang Hoffman
Gustav Jensen
Alexander Kachinsky
William Lescaze
Ray Loewy
J. D. Peters
Winold Reiss
Gilbert Rohde
George Sakier
Joseph Sinel
Lee Simonson
Eugene Schoen
Walter Dorwin Teague
Harold L. VanDoren
Kem Weber
Russell Wright

Addresses of these designers can be supplied by "Electronics," 330 W. 42nd St., New York.

for SALES APPEAL?

same conception of design—a conception which has made the radio industry most backward, from the point of view of design, of all the major industries.

Where there is so little to choose, all competitors may be said to be equal. But that the industry as a whole has been adversely affected is proven to my own satisfaction by the fact that scores of persons in all walks of life have complained to me of their inability to find a "decent looking" radio cabinet which they would be willing to put in their living rooms; many others I know have devised cabinets of their own; and countless others have bought cheaper and smaller sets than they could well afford simply because the less obtrusive cabinet makes less of an eye-sore in their homes.

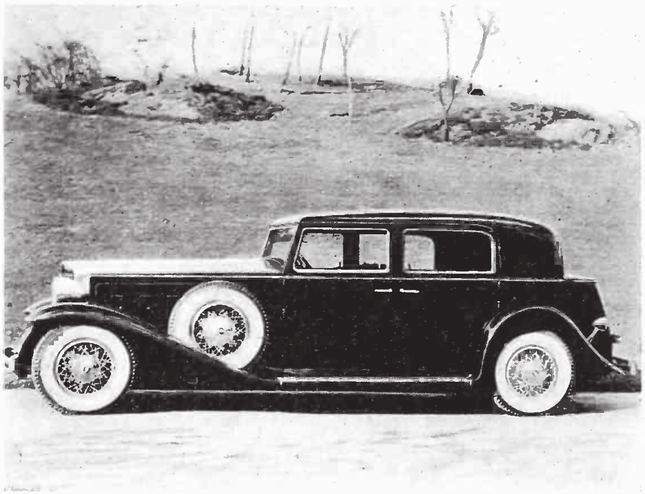
Why should the youngest, most modern, and otherwise most progressive of the major industries be so hopelessly bogged in this one particular? Why does it seem to feel that its up-to-the-minute product must be offered in a disguise—with an apologetic effort to make it look like something it isn't, like something our grandmothers might have owned if our grandmothers had had excessively bad taste? Why does it ignore the trend of popular taste in home furnishings, the growing appreciation of sound design, the leadership of all the many magazines devoted to interior arrangement and decoration? And why does it fail to profit by the experience of other industries in which new and good design has been used to advance sales and pyramid profits?

Some of the answers are obvious, the principal reason, I believe, being that the necessity for keeping down costs has forced the use of sources of supply, in many instances, that are singularly lacking in vision; plus the "follow-my-leader" spirit to be found in all large industries; plus the fact that one or two efforts to import an outside viewpoint resulted in dismal failures. (I think I know the reasons for this last, but as I have only suspicions to go on they shall be unvoiced).

Radio's stalemate will not last

But no industry can remain stalemated forever. Some one is bound to step out of line and make a wholly fresh approach to this cabinet problem, producing a line of cabinets that will instantly register on the public consciousness by their individuality, and sweep the market because of their beauty and appropriateness. It would not be a difficult thing to do, given a designer of real creative ability and a manufacturing organization imbued with a spirit of enthusiastic cooperation.

We shall then see something closely paralleling the history of the automobile industry, which certainly has the "follow-my-leader" spirit as strongly as any other. In the automobile world, *every major success for years past has been the result of a decided and advanced innovation in design;* and every one of these steps forward has been in the same direction—further away from the original carriage type, closer and closer to the ideal of a stream-lined, motor-driven projectile. After each one of these popular successes there has been a scurrying effort by other manufacturers to pull their models up to the new level; and they have then marked time until some one with vision and confidence has shown them the next step.



Compared with the modern automobile, radio is still in the "Model T stage," declares the designer of this Marmon Sixteen, a car that has had great influence on all recent automobiles

This process has kept the public keenly interested in automotive design, on the qui vive for innovations; and has enormously increased automobile sales through style changes and obsolescence. The same thing to a lesser degree but with gratifying effect on profits has been accomplished in many other industries: cameras, alarm clocks, bathroom fixtures, gas ranges, furnaces, glassware, weighing machines, glass food containers, to mention only a few. The value of sound and progressive design has been proven so many times that it seems hardly necessary to cite instances.

There was a time when Henry Ford could manufacture his Model T for ten years without change; today the occasional Model T still to be encountered on the highways is only a ludicrous survival of another age.

The radio industry is now in the Model T stage. But unquestionably someone soon is going to step out and end this period of marking time; he is going to reveal to the public some of the possibilities of beauty and charm latent in radio cabinets. And what a lucky manufacturer *he* will turn out to be!

Radio will parallel the auto

RADIO will parallel the history of the automobile. In the automobile world every major success for years past has been the result of a decided and advanced innovation in design.

This process has enormously increased automobile sales through style changes and obsolescence.

Prices of components tend to stabilize

New tubes, models still plague the industry

COMPONENTS and raw material manufacturers, supplying the radio industry with the parts out of which sets are made, like the rest of the world, have felt the east wind. Prices have dropped during a year from 25 to 50 per cent and even more in some cases. Coils, condensers, resistors, insulation, metals—all have come down and seem to be approaching, asymptotically, a more or less stabilized level.

Tube manufacturers have engaged in a money wasting campaign to increase the numbers of tubes; each new model a manufacturer takes on costs about $5,000, which represents the profits on many tubes. And yet so anxious are the manufacturers to hurry the day of doom they will bring out a new type only to discover that an existing type with slight variations in recommended voltages will produce exactly the same result!

Old-line set manufacturers, caught napping by the "universal" fad, have watched 100,000 of the a.c.-d.c. sets go into the market each representing a profit to the maker, to the dealer, and supposedly to the buyer; and in this case the maker is a manufacturer from whom little has been heard previously.

Components prices

Among the parts going into radio sets the case of coils is characteristic. A year ago prices were coming down but quality was holding up pretty well. Now everything is going by the board in the race to get business at lower prices. The vest-pocket type of set using a two-gang condenser has four tuned circuits. A manufacturer will pay about as much for the two coils as he would for single coils a year ago.

Electrolytic condensers of the dry type, selling at 27 cents per 8-μf have maintained their price very well, largely because of the license situation. All dry condensers are licensed by one company; therefore it is not difficult to keep the selling prices at a profitable level. The trouble with this situation is that the wet condenser which does not enjoy any such stabilizing influence is getting more and more of the total condenser business. These condensers can be sold about 5 cents lower per 8-uf. Some readjustments in dry-condenser prices may be forced by this situation.

Volume controls that a year ago sold for 29 cents now bring 25 cents. Fixed resistors have gone down about 50 per cent. Units which brought seven to eight cents a year ago now are lucky to move at 3 cents.

New metals for tubes

And so it goes. If prices do not come down, manufacturers find a way to avoid the product. The tube industry is a good example. For five years, at least, tube engineers have experimented with iron and other metals for plates and other structures now annually consuming many tons of nickel which is more expensive.

Now it appears that at least one company has mastered the art of using steel for anodes; rumor has it that this company has gone 100 per cent to the metal; other companies are learning the technique, and as soon as high inventories of nickel products are exhausted they may turn to steel. The Swedish Iron and Steel Company (*Electronics*, December, 1932, page 379) has been very active in working with tube engineers. The National Carbon Company has developed extruded carbon plates which are now being used in power tubes from the 210 in size up. This new development may find its way into the receiving tube business. At the same time new alloy wires are on the way for grids, etc. Allan Bradley has developed a carbon enamel for plates to reduce secondary emission.

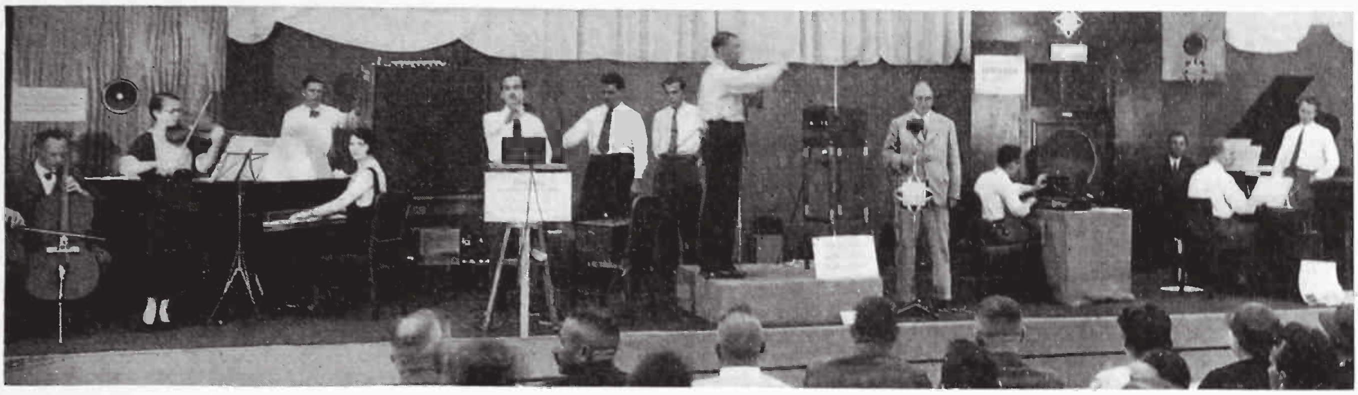
It is possible that not all of these developments will work in the direction of reducing prices of making tubes; but anything that effects any decrease in cost will secure immediate attention from tube executives. The next move is to revamp or simplify processes—either by developing new methods, or by reducing quality.

Trends in set design

The four-tube t.r.f. universal receiver seems to be definitely out of the picture, after its exciting whirl, in favor of five-tube supers in about the same cabinet size. The next move, of course, is to so improve the four-tube set that it will again command the market (because it will be lower in price than a five-tube job). Tube makers have contributed much to the small set game. Combining two functions in one envelope reduces the space requirements.

Ultimately, perhaps, there will be a two-tube super. The first tube will be a detector-oscillator (*Electronics*, February, 1933, page 35, and this issue, page 76) and the second tube will be a detector-power output tube. This will reduce the receiver to its lowest terms—then the industry need no longer worry about reductions in the size of the midget. Indications are already in sight that manufacturers will abandon the intermediate set; there will be a very cheap model, and a better model.

All of these indications may or may not be favorable; certainly there are other trends that are distinctly favorable. There are new receivers which are reported to excel the past art in fidelity and realism and power output. Loudspeakers are on the way that will transmit the higher frequencies better than existing speakers. New acoustic cabinet material, new forms of tone control, and still other new features will aim to improve fidelity to a point easily demonstrable to the ear. In addition there will be a determined effort to bring beauty into cabinet design on the theory that if engineering excellence and low price cannot move radios, beauty of line will be more successful.



An orchestra of electronic musical instruments playing at the Berlin Radio Show last summer. From left to right are shown the Vierling apparatus, Theremin, Trautonium, Hellertion, and Bechstein piano

Electronic musical instruments of Europe and U.S.

DURING recent years, electronic musical instruments have been objects of enthusiastic interest on the part of the music-loving population of Europe, particularly Germany and France. This popular fad of electronic music now bids fair to cross the Atlantic to America.

Already a number of electronic musical devices have been developed by American inventors. Notable among the radio men who have turned their attention in this direction, is Benjamin F. Miessner, of Short Hills, N. J., whose electronic piano was last month demonstrated in New York City. Mr. Miessner recently returned from a visit to Germany where he made a thorough study of European musical devices of the new order, and at the request of the editors of *Electronics*, has supplied the following list of electronic musical instruments commercially available in Europe and the United States.

The Nernst-Siemens Bechstein (electric piano)

This instrument was developed from the original work of Oscar Vierling of the Heinrich Hertz Institute for Oscillation Research, Berlin, through a collaboration of Dr. Walter Nernst, C. Bechstein, piano manufacturers, and Siemens, A. G., the well-known electrical manufacturers. The instrument looks like a small grand piano and has strings, keyboard-hammer action (but no soundboard), magnetic pick-up devices for converting string vibration into alternating voltages, an amplifier, and a loudspeaker. It has fixed tone quality and two degrees of string damping. An electric phonograph and a simple radio receiver are also included. The price in Germany is 2,800 marks, equivalent to about $700.

The Foerster Electrachord (electric piano) is an instrument which was developed from the designs of Oskar Vierling, of Germany, and B. F. Miessner and C. T. Jacobs, of the United States, by the piano manufacturers August Foerster and the electrical manufacturing firm of Lorenz. This is made in both grand and upright types combined with phonograph and radio. It has strings, a keyboard-hammer action, but no soundboard, magnetic pick-up devices for converting string vibration into alternating voltages, an amplifier, and loudspeaker. It has fixed tone quality, variable damping, and is playable also as an organ. The price in Germany is about 3,000 marks or $750.

The Conpleaux Brother (electric organ)

This is manufactured by Conpleaux Brother, of Lille, France. It employs about 400 vacuum tubes in an audio oscillator controllable by three manuals, and fifteen tone quality stops. The various tone qualities are obtained by fifteen different amplifier and speaker outfits, each with a different frequency characteristic. A number of installations have been made, one of which is in the Post Parisienne broadcasting station. The cost varies with size but is in the range of thousands of dollars.

The Trautonium

This is manufactured by the Telefunken Company of Berlin from the designs of its inventor Dr. Friederich Trautwein, of the Technical High School for Music in Berlin. This instrument consists of a neon oscillator whose frequency is controlled by the variable very high resistance of a vacuum tube of variable grid bias. A wire about two feet long is stretched over a base and when this is pressed at different points, different tones are produced. Only one tone at a time can be thus produced. The tone quality is variable by control of the so-called "Formants." Since the neon tube provides the fundamental frequency in a "saw-tooth" wave shape, a higher frequency tuned circuit of damping variable from positive to negative values, various types of over tone structure may be produced. The oscillations of this "Formant" circuit are wiped out and renewed for each fundamental period. The circuit is quite simple and the

[*Please turn to page 72*].

Editors' Note: The Miessner electronic piano, which the author of the above notes modestly omits describing, is an instrument which looks like a grand piano, but plays also like an organ, flute, saxophone, guitar, harp, bassoon or other instrument, permitting even full-orchestra effects. The vibrations of the piano strings are picked up by microphones, and the electrical oscillations modulated in various ways, before being heard through special amplifiers and loudspeakers.

Proper sites for broadcast stations

A radical proposal to improve receiving conditions

By C. W. HORN
Chief Engineer,
National Broadcasting Company, Inc.

IN AN activity in which technical improvements cause changes as rapidly as in radio broadcasting it is essential that we revise our specifications at frequent intervals. It is general engineering practice first to set up the problem which must be solved and then to utilize whatever means are available for designing and constructing the most efficient equipment to meet that problem. Therefore as engineering development primarily attempts to overcome difficulties being experienced, it is fair to say that we must first have need or demand for improvements before they are forthcoming.

In fact one very effective way of encouraging advances in the art is to force the issue by setting up requirements, having as their aim the refinement and perfection of the general service to the public. This is well illustrated by the action of the Federal Radio Commission in demanding frequency stability which was met by manufacturers when they produced apparatus keeping the frequency of transmitters well within the 50 cycle tolerance which the Commission specified.

There is another well recognized example. Years ago there was no great demand for selectivity in receivers, and the manufacturers naturally paid more attention to what they considered more important details. At that time they were more concerned with sensitivity because of the low powers used by the transmitters. With the increase in the number of stations, however, selectivity became a problem, and was met quite successfully by the designers of receiving sets.

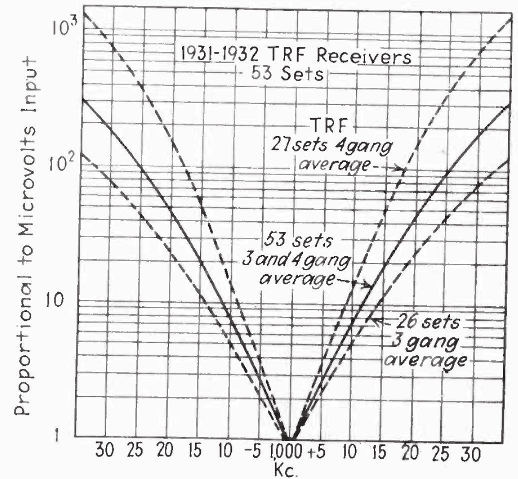


Fig. 1—Selectivity curves of tuned radio-frequency sets of 1931-1932

So well has the selectivity problem been met, especially by the superheterodynes of 1931 and 1932 that another great technical and economic advance is now easily possible. This concerns itself with the question of the proper location of a broadcast transmitting station. The time has arrived when the next progressive step should be taken to improve the service to the public and at the same time force design engineers to continue developing equipment to better conditions.

To determine the ideal location of a transmitting station, we must first ask the question of what we are striving to accomplish. What must a broadcasting station do to provide the best service possible for the greatest number of listeners? The answer is simple. It must serve the territory to which it has been assigned as efficiently as possible. This brings up the question of what the listeners are entitled to and what they can be given with due regard to the existing limitations. The listener naturally expects first-class service from his local station. In an area which is widely extended such as the metropolitan area of New York, or that of Chicago, we find that he frequently does not obtain good service from his local station. For example in the New York metropolitan district, are many millions of inhabitants scattered over a rather large area. Many of these are not obtaining first-class service to which they are entitled. Surveys which I have made and the large number of letters received indicate dissatisfaction. We have probably the most difficult area in the world to serve from a single station, because:—

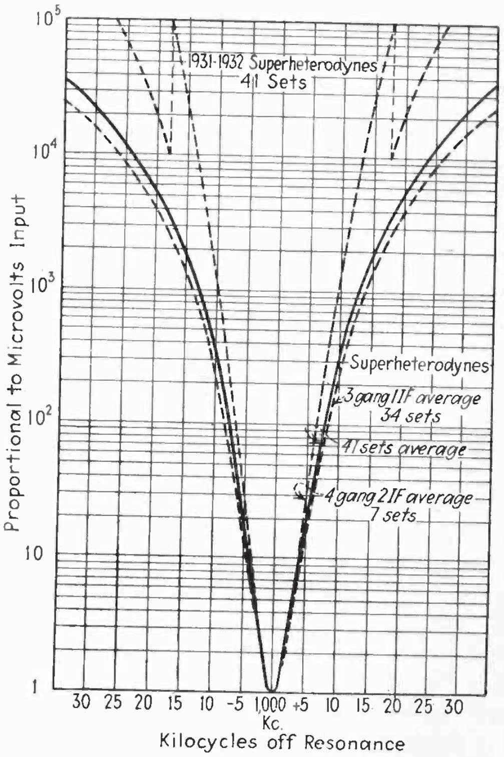


Fig. 2—Selectivity of superheterodynes of 3- and 4-gang types

It is large in extent: because steel structures of great magnitude throw radio shadows of considerable area; and because highly electrified conditions cause high noise levels.

Therefore, additional factors must be considered in choosing the site for a transmitter, the importance of which greatly outweigh some of those taken into account when the rules now in existence were made.

If an illuminating engineer were told that he could use only one light and that that light could not exceed a certain value, and that it had to serve a particular area as efficiently as possible, he would naturally plot the area which must be covered and locate his light somewhere near the center of that territory. As radiations from a transmitting station follow in general the theory of light radiations, the problem is almost identical. It would be necessary for the illuminating engineer to make sure that he did not blind people with too much light near the source of illumination, and to do this he would have to determine just how much light the eye could endure without discomfort. It is the same thing that we attempt to do in the case of a radio station. Fortunately the amount of power, even 50 kw., which is now the highest authorized, is not so great an amount as to cause any real difficulties at the present time.

The Federal Radio Commission has acted wisely in being conservative. I have no criticism of its general attitude but the time has arrived when new factors must be considered and perhaps a change made. I feel it is the duty of those in the technical field to bring such matters to the attention of the industry when it is felt that sufficient advances have been made to warrant changes. I feel that we can now locate stations to obtain greater efficiency because noticeable improvements have been made in overcoming the obstacles that prevented such a move prior to this time.

When so-called "high power" first came into being, the frequencies of transmitters were only approximate to those assigned. As the channels were 10 kc. apart a great deal of interference was encountered because it was difficult to keep a transmitter within even 1 kc. of its assigned frequency. Because the stations had comparatively little power, the receiving set manufacturers solved the problem as they saw it by producing very sensitive sets. In making a receiver very sensitive they necessarily produced apparatus that was not highly selective, and because of the novelty of radio the listener was intrigued with the possibility of receiving over great distances.

Demise of the "dx" craze

However, all this was in the days before networks, and just as the far pastures seem to be the greenest, the listeners, becoming accustomed to the local programs, desired to hear other features from the more distant stations. Different stations put on highly attractive programs and there was a great deal of complaining if the local stations caused any interference with reception from distant stations. All of this was logical because the listener had to tune around to obtain a program with some desirable talent. Even if only a limited number of stations could afford to put on an outstanding feature but once a week, many within a reasonable range attempted to receive that program. Before the days of networks the individual station could not afford to put on outstanding programs as a regular service and for many hours each day, because of lack of talent available in cities not a program center and because the expense was too great for a single station to undertake.

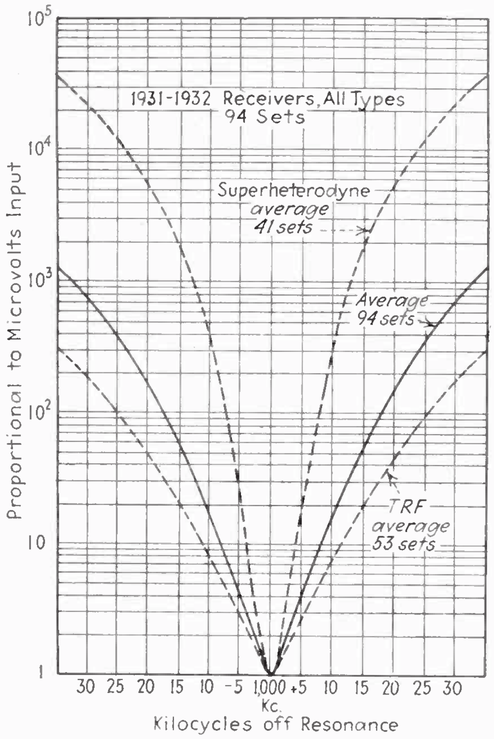


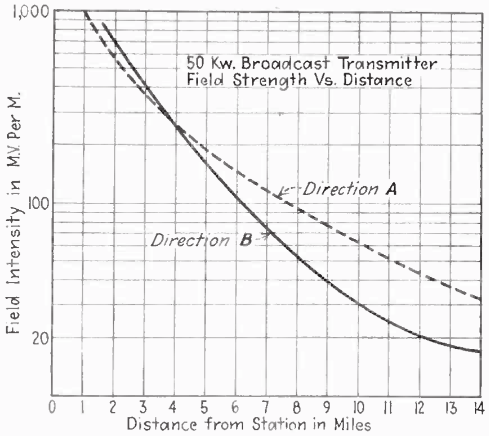
Fig. 3—Average selectivity of superheterodyne and tuned r-f receivers

Therefore it was necessary to place the more powerful stations far out-of-town to keep the level of their signals at a point where interference with distant reception would be at a minimum. The transmitters were not efficient, and the receiving sets were non-selective, as well as unshielded, and in other ways inefficient. The listeners were not yet concerned much with quality because sufficient progress had not been made along these lines.

Such were the reasons why the present specifications for locating a station are in effect. Now, however, the situation is vastly improved. In the first place, transmitting stations operate on their assigned frequencies with very little deviation; in the second place, the receiving sets have undergone a radical change, and we now have highly selective thoroughly shielded sets much less subject to interference.

There is practically no "DX" listening, except by a limited few. The listener is interested primarily in the program value and the quality of the received signals. Transmitters have been greatly improved in quality as have the receivers and loudspeakers, so that high quality renditions can now be reproduced in a satisfactory manner. The listener has also learned that the best quality is obtained from the nearby station, and not from a distant one subject to interference by static, crosstalk, fading, etc. Musical authorities have come to recognize radio as a medium which can transmit fine renditions, which accounts for their endorsing radio, where formerly it was difficult to obtain high-class talent. As an example, we are now broadcasting Metropolitan Operas, and the finest symphonies—all with no questioning of its quality, provided, of course, the listener has a suitable receiver such as are now available.

Due to improvements in line transmissions it is possible to convey such high quality to stations throughout the country. Where local stations heretofore could not afford to put on many hours of high priced talent, the networks now can do so, with the result that there is no incentive to tune to stations in distant cities for pro-



Field strength of a New York station in its best and poorest directions

grams which formerly could not be obtained locally. This is the strongest argument why the broadcast system should be readjusted to give the listeners improved service from stations located in their vicinity.

As an illustration of how the present system discriminates against this "ideal" which I have tried to bring out above, I might cite the case of stations in the Metropolitan area of New York. Because the present rules require that a station utilizing 25 or 50 kw. must be located at a considerable distance from any population center a great hardship is caused to listeners residing in territory on the far side of the city. In an area that is as large as the New York area a station located outside of the eastern borders of this dense population is very poorly received in the western portion of the territory. This is doubly true in the case of New York City because of the high attenuation due to steel structures. Stations located southwest of New York City are giving impaired service to many listeners in the north and eastern portions of the city. It is true of every large station in the New York area that they serve efficiently only a portion of the territory.

A remedy for sunspot radio disturbance

Another factor has become important during the last two years. Because of sunspots, or whatever may be the cause, this last year has seen excellent skywave transmitting conditions. Stations at quite a distance can occasionally be received with a very strong signal. Therefore, if the local station is not giving a strong signal, some interference is experienced from these neighboring channel stations, within what is called the ground-wave service area of the local station. Listeners have complained that they are not getting satisfactory service from the local station to which they feel entitled. They cannot tune to the distant stations for good service because these distant signals fade and have merely a great annoyance value.

The solution is to raise the signal level of the local station throughout the territory it is serving. This territory is the ground wave service area out to a point where fading may be expected. Merely raising the power of this local station does not always improve matters, for we know that it requires four times as much power in the transmitter to give double the signal strength, and that added power is only partially effective, as doubling a weak signal does not help much, unless the receiver is at the border-line where just a little more signal would greatly improve matters.

The curves accompanying this article indicate the degree of selectivity of the average receiving sets in use at the beginning of the year 1932. In order to be fair, these curves were made on a total of 94 receiving sets offered for sale by different manufacturers. Of the more selective styles of receivers the curves indicate that the ratio of response of wanted to unwanted signal is as high as 1,000 to one in field strength when 10 kc. removed. In the case of 20 kc. difference, the ratio is over 100,000 to one in the most selective types. Even in the least selective sets a ratio of 50 to one may be expected at 20 kc. separation.

As the Federal Radio Commission's regulations require a separation of 50 kc. between stations assigned to the same city, it is evident that modern receivers can be placed within a mile of a 50-kw. station and have absolutely no difficulty receiving from any other local station in that locality. The only criticism which can be offered against this line of reasoning is that there are still in operation a considerable number of ancient non-selective receiving sets. To refuse or make impossible improved service to a large number of listeners because there are still a number of obsolete receivers in use controverts all ideas of progress. For there to be no progress until these obsolete receivers fall to pieces or die of old age is utterly unreasonable. Just as manufacturers will not build improved receivers unless there is the demand for them, just so will there be no improvement in general reception conditions until a situation is created whereby these few obsolete receiving sets must be replaced.

Transmitters should be located near the listener

Having demonstrated that progress in the art has made it possible to locate transmitting stations quite close to densely populated centers without causing any more interference than was experienced a few years ago to these same listeners from a station quite far removed, I feel it is logical to suggest that transmitting stations now be permitted to find sites somewhere near the center of the territory to be served. In most areas it is possible to find either highly industrialized sections or swamp areas, or other sparsely populated localities, somewhere near the center of the territory to be served. The only requirement now is that the least number of people possible live within a mile or less of such a site. Such localities exist quite near the center of New York which would serve admirably. This holds true for practically every city, so that there is no need now of forcing the stations to locate well outside of the city. If all large stations were to group themselves in the same vicinity there would be no interference problem at all, even for the non-selective, obsolete receivers.

What would be the benefits if a 50-kw. station were located somewhere near the center of the New York metropolitan area, for example in the Jersey meadows between the Palisades and Newark? Here are many miles of swamp land practically uninhabited, where it would be quite easy to find a site a mile or more from any considerable number of homes. A station located at this point would give a high quality usable signal to all of the densely inhabited portion of the metropolitan area. This signal would extend up beyond Bridgeport, Connecticut, over to Nassau and Queens, as well as Brooklyn, and would give excellent service to the suburban territory in Northern New Jersey in which several million people reside. Every one of the larger stations as located at present has a fading band and consequent poor service in a large portion of the territory it is intended to serve. By putting the station near the center of the area this fading band will be pushed out beyond the suburban areas.

Moving a station into town would therefore create a very large gain in service. In the case of the New York area millions of listeners or potential listeners would be given greatly improved service if advantage is taken of the improved design of transmitters and receivers which have been available for more than a year past. There would be very little complaint, and this could automatically be taken care of by advice from radio editors of newspapers and general publicity. A broadcasting station is intended to serve the public which I interpret to mean the great majority and not a selected few. For this reason I feel that the Federal Radio Commission could very well change its requirements, and classify areas having a thousand or more millivolts per meter as blanket areas instead of the figure of 100 millivolts as at present. Radio manufacturers will give added attention to more complete shielding and selectivity of receiving sets so that in time even 1000 millivolts can be exceeded.

In urban areas where the noise level is high, experience has shown that at least a 10-millivolt signal is necessary to insure interference-free service. Highly electrified areas like New York are not receiving such service at present. Only a small portion of the total area is in the ten-millivolt line of any one of the stations. Therefore, listeners in such an area as New York are receiving poorer service than smaller cities throughout the country.

I feel that we have reached the point where such a change is desirable, and that we must begin to think of radio problems from a "system" standpoint, rather than the way we have been doing heretofore. Formerly the transmitting engineer solved his problems, and the receiving engineer did the same in his field. The time has arrived when the broadcasting system engineer is the one who should set the specifications, and in cooperation with the transmitting and receiving engineers, develop apparatus so as to engineer the whole problem as a system of distribution for the benefit of the greatest number.

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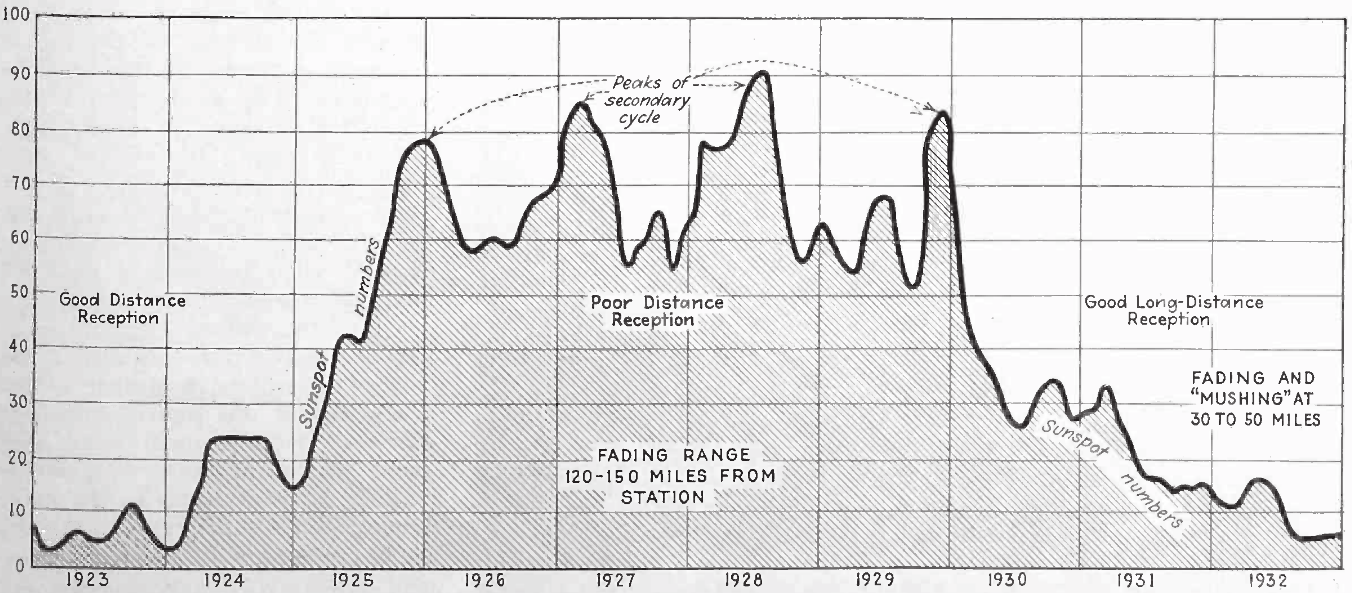
Changes in sun-spot numbers 1923 to 1932 give clue to radio vagaries

INTERESTING correlation between the number of sunspots present at any time, and the corresponding radio reception conditions, is suggested by this chart showing the sunspot numbers for the past ten years as compiled by Dr. Harlan T. Stetson, director of Perkins Observatory, Delaware, Ohio.

Dr. Stetson's radio studies, in collaboration with Dr. Greenleaf W. Pickard, show that long-distance broadcast reception follows inversely the curve of the Wolfer sunspot numbers. We are now at a sunspot minimum, and are experiencing distance reception of intensities nearly 400 per cent of those of a few years ago. The clarity with which broadcast signals at present come across the continent or from distant stations is now evident to every listener. Similar receiving conditions obtained in the early days of broadcasting, 1922 and 1923, when, as old-timers remember, little 50-watt stations could be heard across the country.

The present exceptional strength of distance signal or sky-wave, while benefiting distance listeners, has its drawbacks for listeners 30 to 80 miles from large stations, who are now suffering annoying fading and "mushing" of signals, owing to the strong sky-wave interfering with the ground-wave much closer in to the station than obtained a few years ago. During the sunspot maximum (1926 to 1929) this fading area seldom came within 100 to 150 miles of the transmitter. Sunspot numbers have been recorded for over a hundred years; the cycle averages eleven years, and the curve should shortly turn up.

The chart below clearly shows the secondary 15-month cycle discovered by Dr. Stetson, introducing corresponding peaks on the main curve. The last four peaks were predicted by Dr. Stetson in advance, and he found that each secondary peak also shows its effect on radio reception.



This variation in the number of sun-spots present, over the last ten years, seems associated with the changes in radio reception conditions in both broadcasting and short-wave bands

The Kathetron—

A control tube with external grid

By PALMER H. CRAIG, Ph. D.
The Invex Corporation

THE name Kathetron is derived from the Greek verb ϰαθεω meaning to control. It is applied to a gaseous discharge tube with an external grid which controls the anode current either by variable potential on this grid or by means of a changing phase relation between this potential and that of the arc itself.

The fundamental circuit of this variable amplitude voltage control is shown in Fig. 1a, where is a transformer for supplying potential to an external grid *C*, which is placed around a mercury vapor rectifier tube. The arm to the variable resistor allows a greater or less potential to be impressed between the external grid and the cathode. Equally good, and in some cases better control is obtained when this variable potential is impressed between the external grid and the anode. By these circuits it is possible to completely extinguish the arc or to vary the current flowing by any desired amount, from complete extinction to the maximum current obtainable with the other circuit constants. An initial phase displacement between anode-cathode and grid-cathode potentials is produced by the fixed condenser; but the phase difference is not changed during the operation of these control circuits.

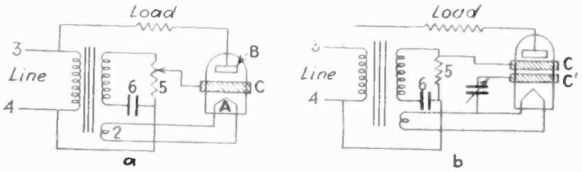


Fig. 1—Fundamental circuits of the Kathetron tube

Many standard mercury vapor rectifier tubes may be used with this type of control. Figure 2 illustrates a few typical types, ranging from a small tube about $\frac{3}{8}$ of an inch in diameter to tubes capable of handling 15 amperes or more. Ordinarily, hot cathode mercury vapor tubes are employed although the cathodic spot type may also be used. Normally, the external grid is simply a cage of a few pieces of wire or a mesh of metallic gauze. It may, however, be foil, sheet, or electro-deposited metallic films. Normally, the voltage on the grid is at least two and one-half times the inverse voltage between anode-cathode, but in special tubes may sometimes be as low as 5 volts or less, when the inverse voltage across the tube is 120 volts.

In another method of control a small variable condenser is placed in the grid lead. In still another method (Fig. 1b) two external grids are employed and the control is effected either by varying the grid potential through the potentiometer or through the small variable condenser. It is also possible to insert a small fixed condenser in the upper grid lead of this figure and attach another lead to the same grid through a variable condenser to cathode, thus eliminating entirely the second grid. Full wave circuits may also be employed.

The conditions necessary for the operation of the control circuit may be obtained from Fig. 3. In this figure the relations between voltage waves applied to the anode and to the control electrode are indicated, the zero axis being given by the line 0. The curve *B* indicates the voltage wave applied to the anode. The curve C_b represents a voltage wave applied to the control electrode. The distance *P* represents the phase displacement between the anode voltage and the control electrode voltage. The curve *A* represents a current pulse flowing in the anode circuit. The dashed line (1) indicates a limited voltage below which the arc will not be sustained. The curve (2) indicates the negative voltage necessary to be applied to the control electrode in order to prevent the starting of the arc at different portions of the positive alternation of the anode voltage. This curve has a shape of approximate sinusoidal form, due to the wave form of the anode voltage; as the anode voltage increases in value, the negative voltage required to be impressed upon the control electrode must be greater. If the voltage applied to the control electrode were 180 deg. out of phase with the anode voltage, it will be seen that as the magnitude of this control voltage is increased from a small value to a point where the maximum instantaneous value is equal to the maximum ordinate of curve (2), the curve representing the control voltage will substantially coincide with the curve (2), and the arc will be prevented from starting in the positive

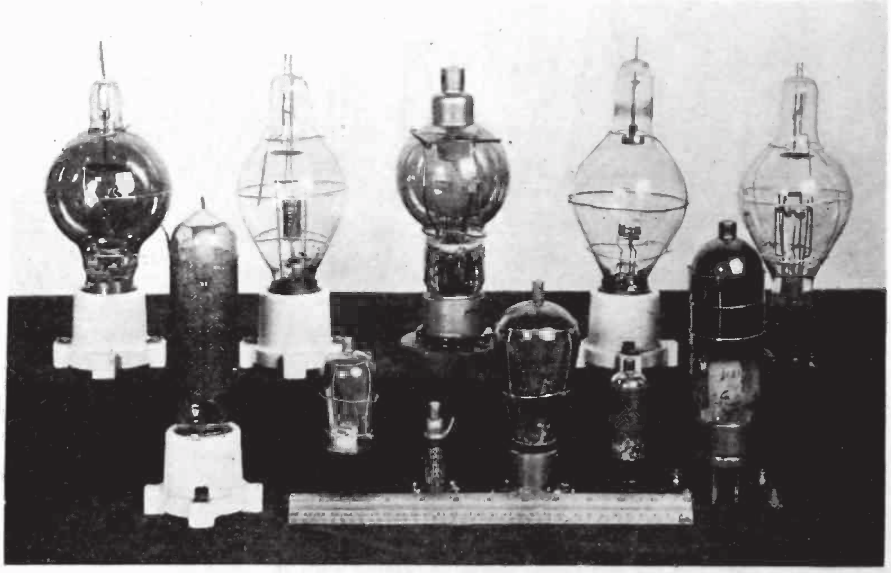


Fig. 2—Rectifier tubes which have been controlled with an external grid

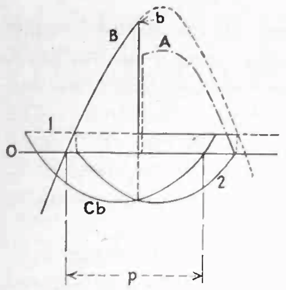


Fig. 3—Relations between grid and anode voltages and anode current

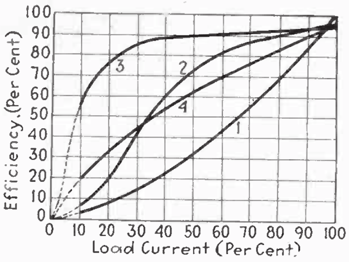


Fig. 4—Efficiency of new circuit compared with other methods of controlling intensity of illumination

alternation of the anode voltage. By reducing the control voltage the arc is permitted to start at a point early in the positive alternation of the anode voltage. It will thus be seen that where the control voltage is 180 deg. out of phase with respect to the anode voltage, only a very slight change in value of the control voltage is necessary to completely cut off the anode current or to allow full anode current to flow. Such type of control is termed "on-and-off" control. To obtain a control which varies the anode current continuously and progressively in accordance with the magnitude of the voltage applied to the control electrode, a voltage is applied to the control electrode, and for this purpose condenser 6 is inserted in series with resistance 5.

The anode voltage curve B and the anode current curve *A* in Fig. 3 illustrate the operation obtained with a control voltage wave represented by curve *Cb*. It will be seen that curve *B* is drawn in solid lines to point *b*, then vertically downward to the horizontal line (1) then horizontally to the right until it reaches the extended envelope of its sine wave form. The curve *A*, representing the current pulse flowing in the anode circuit rises abruptly from zero to a value near its peak value immediately following the point *b*, and then continues in a sinusoidal form until the arc is extinguished at the end of the alternation. At the instant of starting of the arc, the anode voltage abruptly drops to a constant value represented by dashed line (1) of the order of 15 to 20 volts, and it remains at this value throughout the remaining part of the alternation. The dotted portion of curve *B* represents the sinusoidal outline which the anode voltage wave would assume in case no current flows through the anode circuit.

By increasing the control voltage the starting of the arc will be delayed. The time at which the arc starts in the positive pulsation may be controlled by varying the magnitude of the control voltage, keeping the phase of this voltage fixed. Since the effective value of the anode current is dependent not only upon the maximum instantaneous value but also upon the duration of each pulse, it will be seen that the effective value of the load current may be controlled by varying the magnitude of the control voltage.

Increased efficiency of the Kathetron

Efficiency measurements with ordinary meters on Kathetron circuits are apt to be in error due to the peculiar waveform of the output as indicated in Fig. 3. A more accurate determination could be obtained by the integration of oscillograms. Indicating and integrating wattmeters give a fair indication of efficiency, however, and Fig. 4 illustrates how the efficiency of a typical 2 kw. Kathetron dimmer compares with other forms of control for the same load, when measured by indicating wattmeters.

Curve 1 of Fig. 4 illustrates the efficiency of a simple resistance dimmer system in which a variable resistance is inserted in series with the load. The drooping character of this curve is due to the high positive temperature coefficient of the load. Curve 2 is an efficiency curve for dimmer circuits of the type employing a saturable core reactor connected in series with the lamp load. Curve 3 illustrates the efficiency of dimmer circuits of the type shown in Fig. 5, and curve 4 illustrates the efficiency of a circuit wherein a variable resistance is substituted for the control tube.

From an inspection of the curves shown in Fig. 4 it will be seen that while the simple resistance dimmer system is 100 per cent efficient at full load, this circuit is very inefficient at less than full load values, and is, therefore, not suited for dimmer purposes which involve the operation of a circuit for considerable periods at fractional load values. While the efficiency of the thyratron saturable core reactor circuit as shown by curve 2 maintains a fairly high percentage in the neighborhood of full load values, the efficiency of this system drops off sharply below 60 per cent load current. Curve 3 illustrates the efficiency of the Kathetron reflected impedance circuit, and the advantage of this system over the other systems is clearly shown by the materially increased efficiency at load values ranging from 60 per cent full load current downwards. The advantage of this system is apparent since the region of increased efficiency falls within the operating range of the usual dimmer system.

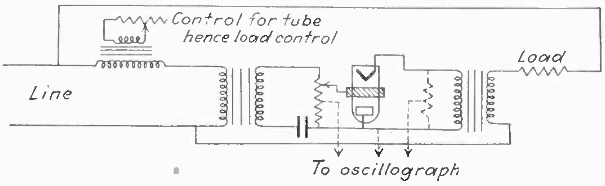


Fig. 5—Reflected-impedance method of improving efficiency of Kathetron circuit

Curve 4 has been inserted to show the advantage of the Kathetron circuit over a system in which a variable resistance replaces the vapor tube shown in Fig. 5. The improved efficiency of the Kathetron system is due mainly to the fact that the vapor electric tube possesses low internal impedance. Within the working range of the tube, the voltage drop across the tube remains substantially constant at from 10 to 25 volts depending upon the particular construction of the tube. The advantage of inserting a step-up transformer between the load circuit and the tube, instead of inserting the tube directly in the load circuit, is that a tube of relatively small current carrying capacity may be employed, thereby resulting in less loss within the tube itself and in a material reduction in the losses incidental to the operation of the tube, such as the filament circuit losses, etc.

This advantage will become apparent by comparison of the losses incidental to the operation of a tube capable of carrying directly a full load current of 15 amperes, and the losses in a tube required to handle the same load current through a step-up transformer of 10 to 1 ratio. The cathode heating losses in these tubes are roughly 125 watts and 25 watts, and the losses within the tubes themselves bear a ratio of 10 to 1. The improved efficiencies of Kathetron reflected-impedance circuits for small load current values is due in part also to the chok-

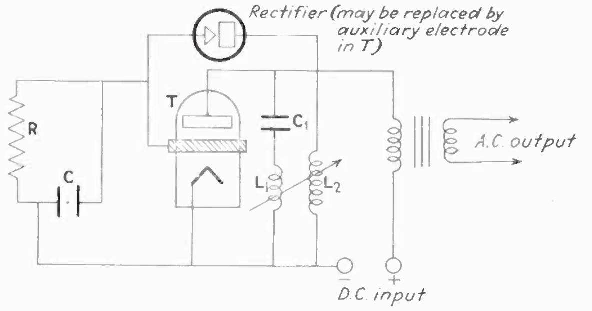


Fig. 6—Inverter circuit for securing a.c. from d.c.

ing effect of the inherent reactance or leakage reactance of the step-up transformer upon the complex current which flows through at less than full load values. This complex current contains a large percentage of current components having frequencies higher than the fundamental or supply frequency and the leakage reactance of the transformers exerts a greater choking effect upon these higher frequency components.

One means for increasing the efficiency of the circuit to a very high point is indicated in Fig. 5, which method we term the reflected-impedance system. In this arrangement it is not necessary for the power control tube to carry all of the load current, in fact, if the ratio in transformer *T* is high, a very small percentage of the load current is handled through the tube. This system obviously increases the voltage across the tube and lowers the current which flows through it. The voltage, however, is not a troublesome factor in most Kathetrons since they are usually built to handle at least several thousand volts. For example, it is very easy to control 15 amperes, with a standard 872 type rectifier tube in an arrangement of this type. The only disadvantage of the circuit lies in the fact that the grid potential must also be raised in proportion to the increased anode potential. A modification of this circuit consists of replacing the primary of transformer *T* with a simple variable resistance.

The most important use of the Kathetron is the control of relatively large power by the expenditure of negligible energy. The external grid consumes little power compared to grids immersed in the ionized vapor of the more usual type of grid-controlled rectifier. Remote control of lamps or motors by means of a small variable condenser or rheostat is one application. The tube can be used as an inverter as shown in Fig. 6 developed by Professor H. J. Reich. It is possible to obtain a.c. output of the order of 100 watts or more from a d.c. supply with this circuit.

With proper adjustment the tube can be made very sensitive to capacity changes. Such circuits are adapted for detection of changes in dielectric of a condenser when materials are passed through the condenser conductors, or for the detection of foreign bodies or other flaws. The actual control exercised by an external grid on a commonly-used rectifier, the 866, will be found in Fig. 7.

Since the potential on the grid is usually negative with respect to the cathode, while the anode is positive, the tube may be used as a voltage regulator. An increase in the input voltage tends to increase the load current due to an increase in anode potential, but this is offset by an increasingly negative screen potential tending to reduce the load current.

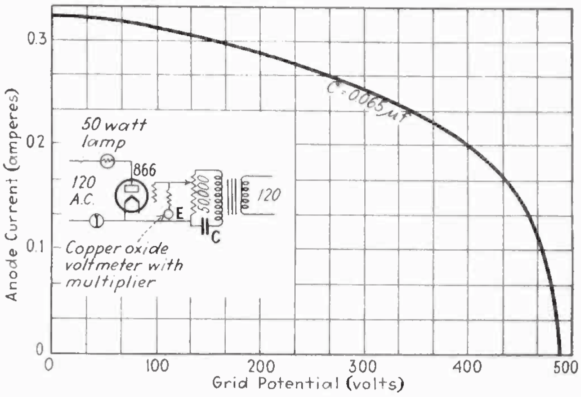


Fig. 7—Control exercised over anode current of a widely-used rectifier

Thus the Kathetron has many applications. Out of the already useful mercury-vapor rectifier a new electric tool has been made.

✦ ✦ ✦

Electronic musical instruments of Europe and the U. S.

[*Continued from page 65*]

outfit for plugging into the audio amplifier and speaker of a radio set, sells for the equivalent of about $25.

The Hellertion

This is being developed for production by the Telefunken Company from the developments of Bruno Hellberger, pianist, of Frankfurt and Dr. Lertes of Leipsig, Germany. It consists essentially of four vacuum tube audio frequency oscillators. The frequency of each of these is controlled by a stretched contactor band. These bands are arranged in parallel formation but at different levels. These are close enough so that with four fingers of one hand one can press down the four bands at different places to produce four different tones so that it is possible to play chords as well as solo. Tremulo, vibrato, glissando, staccato and other types of playing effects may be secured. The price of this instrument is expected to be about $100.

There is a Theremin Company in Berlin also producing this well-known instrument of the "space-control" type. (The New York Theremin Laboratories are located at 37 W. 54th St.)

Jorg Mager, of Darmstadt, Germany, has made some installations of electric chimes for use in Wagnerian productions as well as several electrical organs.

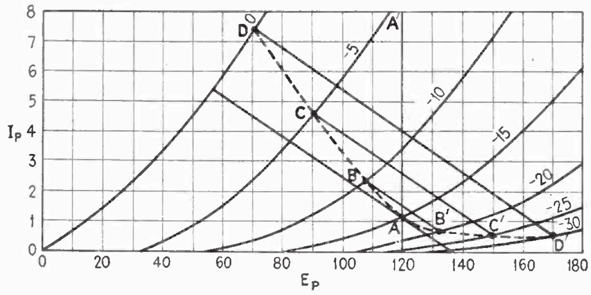
In the United States RCA Victor, Camden, N. J., supplies space Theremins, and electric carillons. R. H. Ranger, Newark, N. J., supplies electrical organs, especially pedal tones. Emicon, Inc., of Deep River, Conn., supplies a keyboard solo type of neon oscillator instrument of two and one-half octaves of variable tone quality, for plugging into radio set a-f. amplifiers. The price is slightly under $60.

The Choralcello Company has for many years been making an electric organ in which interrupted currents through the range of musical frequencies vibrate resonant strings, reeds, bars and diaphragms with horns, etc.

The Electrotone Corporation of America, Ltd., of California, advertises the "Celeste Grand" giving organ tones from grand piano strings.

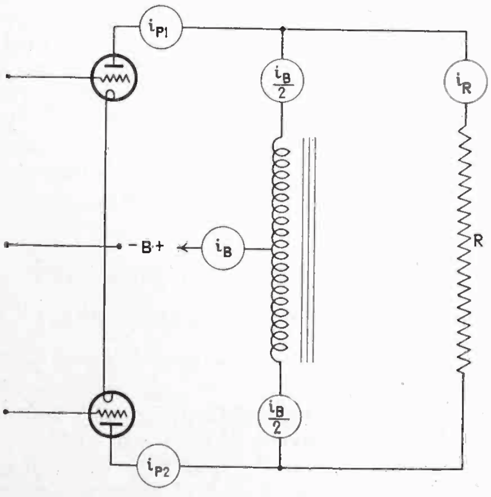
Push-pull amplifier graphics

By C. E. KILGOUR
Crosley Radio Corporation



Typical characteristics of single push-pull tube

BECAUSE of the non linearity of vacuum tubes, straightforward mathematical analysis is often of limited value in the solution of problems in amplification and detection. Given, however the static characteristics of a tube it is usually possible to arrive at the desired solution by graphical methods. This is particularly true of the power audio amplifier for here the load can usually be regarded as pure resistance and hence the action occurs along a straight line drawn on the family of curves showing the plate characteristics.



Circuit of the push-pull amplifier

The method is quite familiar when the stage of amplification consists of a single tube. With a two-tube class A push-pull stage with its standard output transformer it is customary to regard the load in each plate circuit as one-half of the total load across the primary. With two tubes in class B push-pull amplification the load per tube is taken as one-fourth of the total load from plate to plate. In the first case the assumption is correct only if the tubes are linear over the field of action. In the second case the method applies only when one tube is doing all the work.

Obviously if two tubes are operated at a bias giving operation intermediate to class A and class B the division of load must be between that taken for the two cases.

In the schematic diagram R is the load on the transformer as referred to the primary. Since the reactance of the primary is much greater than the load resistance the alternating current will divide approximately equally through the two sides of the primary no matter from which tube it originates. Designating the alternating currents as indicated in the diagram, we have

$$i_B = i_{P1} + i_{P2} \tag{1}$$

$$i_R = i_{P1} - \frac{i_B}{2} = \frac{i_{P1} - i_{P2}}{2} \tag{2}$$

$$e_R = Ri_R = \frac{R}{2}(i_{P1} - i_{P2}) \tag{3}$$

Because of the one-to-one relation of the two halves of the primary we also have

$$e_{P1} = e_{P2} \tag{4}$$

An objection may well be raised at this point. If the currents through the two halves of the primary are equal and of opposite phase there can be no voltage across the primary for it presents no reactance to such balanced currents, and as a consequence there can be no voltage across the load. Actually the alternating currents in the two halves of the primary must be slightly unequal or of somewhat different phase relation than that assumed so that the required voltage is developed. If the inductance is large the unbalance need be very slight so the equations given are very close to exact.

The action on the plate characteristics may be shown by the use of these relations. Assuming that the two output tubes are alike assume on the characteristic of one of them a B supply of 120 volts and a grid bias of minus fifteen volts and an initial point of operation is shown at A. Since equation (3) indicates that the voltage across the load is proportional to half the resistance, the load line is drawn through A so that the cotangent of the angle it makes with the abscissa is one-half of R. For infinitesimal inputs the action will occur along this line about the point A. If the grid of tube No. 2 swings to minus ten volts the grid of No. 2 will swing to minus twenty volts. To find the corresponding plate current for each tube draw a line such as BB' parallel to the load line so that the change in plate voltage for one tube is equal but of opposite sign to that of the other tube. The instantaneous voltage across the load is given by the horizontal projection of the line BB' for it is evident that this voltage satisfies the relations of equation (3).

In a similar manner points C, C', D and D' are located. Draw the lines parallel to the load line so that they are bisected by the vertical line AA' and the conditions are satisfied. Having determined the load voltage against grid swing a plot of e_R versus e_g may be constructed and from this the output power and distortion may be determined. It is also possible to plot plate current against grid swing and determine the average plate current for a given input voltage.

HIGH LIGHTS ON ELECTRONIC

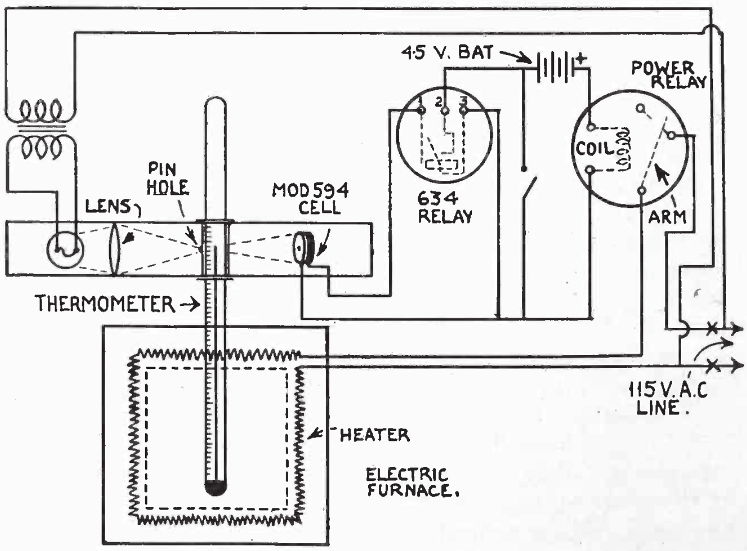
Thermometer control by photronic cell

The photo-electric thermostatic regulator shown was devised for use in connection with an electric heater oven. The same apparatus may be applied in order to solve similar problems, wherever it is necessary to obtain extreme accuracy in the control or regulation of heat.

The photronic heat regulator is far more accurate than a bi-metallic thermostat, of the type often used for turning heater elements "on" and "off." Experience has shown that when the latter method is used, the temperature will vary as much as a degree.

Of course, it is possible to procure a laboratory thermometer graduated as finely as desired and to seal a contact point within this, but such an arrangement is good for only one temperature and furthermore this is likely to be inaccurate. A lens is used to focus a very fine, intense beam of light through a small hole, so that the light will be concentrated on the mercury column of a translucent thermometer, on the engraved side (i.e.—where the mercury is broadest). The thermometer is made adjustable up and down, preferably by a screw adjustment, so that the device may be made to function at any desired temperature. The photronic cell, thermometer and light source are mounted together in one frame, so that there can be no relative displacement, due to jars or vibrations. Construction of the light source, concentrating lens, pin hole, etc., can very well follow that of the "light-head" used in talking movie pick-ups. No light should reach the cell except from the intended light source.

When the mercury column rises past the hole, the light is cut off from the photronic cell and the miniature relay trips and sends current through the power relay. This draws the power relay arm away from one of the contact points, thus opening the circuit to the heater element within the electric oven. As soon as the temperature drops to the desired level, the mercury column falls just enough to permit the beam of light to shine on the photronic cell and the miniature relay then comes back to its original position, cutting the current off from the power relay. The arm of the latter drops back into position permitting the 115-volt alternating current to flow again through the oven heating element. In making the connections, the small (plus) prong of the photronic cell is connected to terminal 3 of the miniature relay and the larger prong is connected to terminal 1. Studs 2 and 3 (connected to a short-circuiting switch) lead to the coil terminals of the power relay, with three 4½-volt dry cells in series. The power relay contact arm is connected to a heater element terminal. The "open" coil contact is connected to one side of the 115-volt a.c. line, while the other side of the line connects to the other heater element terminal, thus the circuit from line to heater element is completed through the relay arm and broken when the power relay coil is energized. The light source is shown connected to the a.c. line through a small step-down transformer, although a small 110-volt lamp may be substituted, without requiring a transformer



The diagram shows how a thermometer or other sensitive measuring instrument can be used to control a photo-sensitive cell, in this case a Weston Photronic unit, the electric eye in turn controlling the relay or motor which is to be actuated at the critical temperature or current value

Pleased with photocell street lighting

Results obtained with the electric-eye control of street lighting in Wallingford, Conn., are reported by A. L. Pierce, local general manager, to be wholly satisfactory. The photocell is mounted so as to get the early morning light from the east. It turns the lights on when the natural illumination drops to about 1½ foot-candles and turns them off when daylight is slightly above 1½ foot-candles. The cell controls directly two transformers which feed circuits radiating to different parts of the town. Cascaded relays then energize transformers which serve the outer areas.

That the sensitivity of the cell is more than adequate is indicated by the experience during a severe thunderstorm when the street lights gave several pronounced "blinks" which were attributed to the response of the cell to the brightness of the lightning flashes although these might have been prevented by "delay" relays. One decided advantage of the installation is the ease with which answers can be given to requests from attorneys as to the exact time of energizing the street lights on particular occasions involved in litigation. These requests are now answered by the simple statement that the street lights are on whenever natural illumination falls below 1½ foot-candles.

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Central secretarial staff employs loudspeakers

By an arrangement of microphones and loudspeakers in the new Haas Building, Los Angeles, Calif., individual tenants when absent from their offices have the use of secretarial assistance from a central office to answer callers, reply to questions, and give information.

When the tenant's door is opened by the caller during the tenant's absence, a light flashes in the central office, and immediately one of the secretarial assistants begins the conversation.

Suppose, for instance, that you are to visit Mr. Jones in his new electric office at the Haas Building. Mr. Jones is out, but you do not know that. Upon entering the door of his reception room, a pleasant voice is heard coming out of the wall.

"Good afternoon, sir," it says. "Will you be kind enough to say what I can do for you?"

"I'm sorry to tell you that Mr. Jones is out," it says. "He is expecting you, though, Mr. Smith, but was called away for a few moments. He will return in 10 minutes. Now in the meantime you will find a folder of information upon

DEVICES IN INDUSTRY + +

the table at your right, which Mr. Jones left there for your inspection. If there is anything more that you wish just push the button on your left and tell me."

But the electric office has many more features than this. Upon Mr. Jones' personal desk is a set of buttons and a microphone. They are indicated as for stenographer, typist, bookkeeper, messenger, etc. When Mr. Jones wants to dictate a letter, he pushes the proper button and a voice from another loudspeaker on the wall asks what he will have done.

"Take this letter to Brown and Company," he begins. The letter completed, he asks that it be repeated to him. "Correct," he says; "please stamp my signature at the bottom and mail it for me."

A centralized staff of trained clerical workers is employed to answer the demands of officeholders. Obviously, this may do away with the need for many personal stenographers, typists, reception clerks, and other office assistants.

Oscillator circuit measures humidity

One industrial humidity recorder and controller contains an oscillating vacuum tube whose frequency is determined by the length of a rayon strip which in turn determines the spacing of two plates making up the grid circuit condenser. Changes in frequency are utilized to operate controls to correct the variation in humidity. This device has been widely used on paper drying machines and responds so quickly that it is possible to control paper moisture content by merely passing the sheet past the rayon strip. Sensitivity of control far in excess of that required is easily obtained.

Killing weevils in wheat by short-wave

When weevils get into grain elevators, it doesn't take them long to ruin enough food to feed a city. Wheat has been known to lose nearly nine-tenths of its value by their efforts. They recover from inert gas even after days of it. Poison gas or mechanical blowers will take care of the weevils themselves, but the eggs and larvae are usually left uninjured to replenish their kind and continue a whirlwind of destruction.

The pests drill holes in the wheat grains, eat out the inside, and use the debris thus left to reproduce themselves every three weeks.

At the instance of J. H. Davis, chief engineer of electric traction of the Baltimore and Ohio Railroad, the problem was attacked by Westinghouse engineers with short-wave radio apparatus. When suitable mixtures of wheat and weevils were exposed to waves of about five meters length, nearly all the weevils died instantly. Even the eggs and larvae succumed in six seconds. It was only occasionally that a particularly tough and dry old weevil would last as long as three seconds. The wheat was uninjured.

The investigation thereupon moved from the laboratory into the field and continued under the supervision of Mr. Davis, who used a short-wave apparatus supplied by the East Pittsburgh research laboratories. Grain passing through a chute was successfully treated at a rate of 60 bushels an hour, with 13.8 kw. of short-wave energy being put into the wheat. The experiments are continuing.

Press stop operated by photocell

The Cornwall Press Limited, printers of the English *Wireless World,* have now introduced the photo-electric cell as a "watcher" to prevent the damage so often caused to printing machines by paper breakage.

In this installation a small lamp is fitted to illuminate one side of the sheet of paper as it passes through the machine; the photocell is in a specially designed housing on the opposite side of the sheet. Normally, the paper obstructs the passage of the light and the photocell is kept dark, but immediately a fracture occurs, light reaches the cell, the relay contacts close and brings into operation the mechanism which stops the machine.

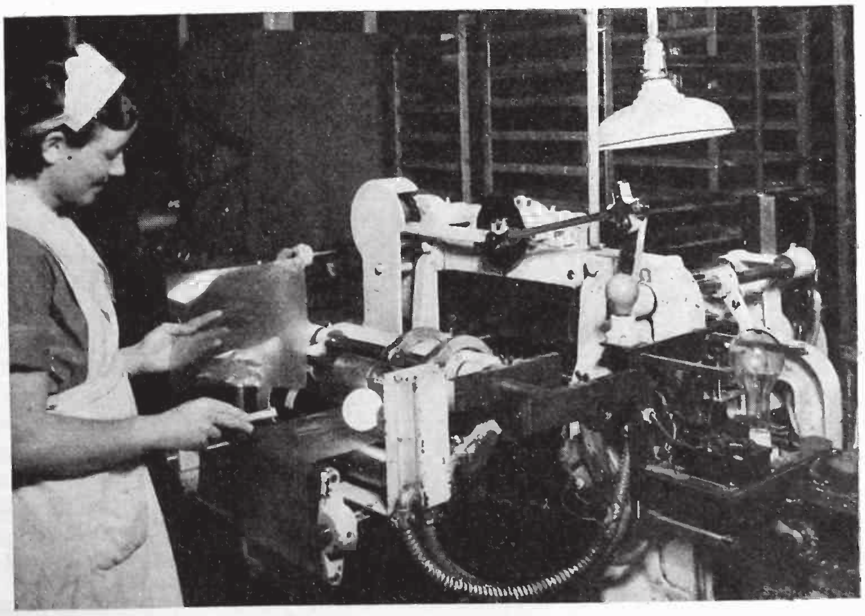
In a recent demonstration given to show the effective action of the photoelectric control, the whole machine came to rest completely in about two seconds after the fracture of the paper.

Without such device a breakage will, if unobserved, often cause the loose roll of paper to wind itself round the cylinders so that the printing plates may become damaged, for it is impossible to be certain that a break will be detected in time by the operators. In addition to the cost of the actual material damage, the waste of time involved in removing and replacing any damaged parts is very expensive.

Control of wood-pulp cooking

In the plant of the Papeteries Navarre, in France, the method of controlling the processing of the paper pulp is based on the close relationship between the degree of cooking and the color of the cooking liquor. The liquor from the digester circulates through a cell with transparent walls placed between a lamp and a photoelectric tube. The deflection of the meter influences a second photoelectric cell connected to an amplifier and a relay, which controls the steam valves of the digester.

CONTROLLING WAX-PAPER CUTTER



This machine built by Package Machinery Company and installed at Williams Bakery in Scranton, Pa., by means of tube apparatus, controls cutting of waxed paper to properly located cut with respect to the printed trade-marks

The emission valve modulator for superheterodynes

By HAROLD A. WHEELER
Bayside Laboratory,
Hazeltine Corporation

THERE have been widely varying estimates of the added cost of a superheterodyne receiver over a TRF receiver, based on the necessity in a superheterodyne of (1) adding an oscillator tube which does not contribute to the amplification, and (2) utilizing the modulator (or first detector) tube under conditions unfavorable for obtaining its maximum amplification, but necessary for its essential function of conversion.

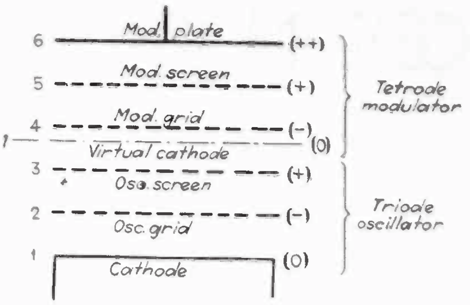
Recent improvements[1] have greatly lessened this handicap, especially insofar as circuits were devised, and are now widely used, which, in many cases, permit the use of a single tetrode or pentode as a combination oscillator-modulator, delivering a conversion gain[2] equal to that obtainable with a modulator tube and a separate oscillator tube. Only tubes having a sharp cutoff were satisfactory for this combined purpose, and the same tube could not be employed for volume control because any substantial reduction in the conversion gain was accompanied by the cessation of oscillations.

In line with the tendency toward greater specialization in vacuum-tube designs, work was carried forward on a new tube to perform the following functions with the simplest possible structure and the minimum cost:

(1) combination oscillator-modulator,
(2) high conversion gain, and
(3) grid-bias volume control.

HEXODE AVERAGE CHARACTERISTICS

	Test Conditions (nominal)		Operating conditions (approximate)	
Modulator plate	+250 v.,	5.5 ma.	+250 v.,	1.5 ma.
Modulator screen	+100 v.,	—0.3 ma.	+100 v.,	—0.1 ma.
Modulator grid	—3 v.,	0 ma.	—3 v.,	0 ma.
Oscillator screen	+100 v.,	13. ma.	+100 v.,	3.5 ma.
Oscillator grid	0 v.,	0.1 ma.	— 30 v.,	0.6 ma.
Total current		18.3 ma.		5.5 ma.
Modulator mutual conductance	970 micromhos			
Modulator plate resistance	0.25 megohm			
Modulator grid bias for one per cent of maximum conversion gain	— 35 v.		— 35 v.	



Arrangement of electrodes in the four-grid detector-oscillator

The second and third requirements seemed at first to be incompatible, because high conversion gain requires a sharp-cutoff grid, and grid-bias volume control requires a gradual-cutoff grid. This problem was solved by locating two separate grids in the same electron stream, each having the structure best adapted to perform its function. The sharp-cutoff grid is used for the oscillator, giving a maximum modulating effect. The gradual-cutoff grid is used for the signal and volume control bias.

Above is a schematic diagram of the special tube which was selected as the best compromise between simplicity, low cost and low cathode current on the one hand, and a high degree of refinement on the other hand. It is a hexode having a structure generally similar to the 58 tube, but having a fourth grid and a redesign of all the grids. This was found to be the smallest number of grids which could be used and still meet the requirements. The cathode and the inner two grids are used as a triode oscillator. The outer two grids and the plate are used as the grid and plate electrodes of a tetrode modulator. The relative polarities of the electrodes are indicated on the diagram.

In operation, electrons emitted from the cathode 1 are attracted to the positive screen 3 through the meshes of the negative grid 2. As the electrons approach the screen 3, they are traveling at a high speed, so that most of them shoot through the screen 3 and approach the negative grid 4, where they are retarded and then attracted back to the screen 3. The cloud of retarded electrons between the screen 3 and the grid 4 is called a "virtual cathode," because electrons can readily be drawn away from this cloud in the same manner they were originally drawn away from the actual cathode. The relative position of the virtual cathode is indicated by the line 7 (which is not a part of the tube structure).

The modulator section of the tube includes the modulater control-grid 4, the modulator screen 5, and the plate 6, in addition to the virtual cathode 7 (formed by the oscillator section of the tube).

Part of the electrons arriving at the virtual cathode 7 are attracted toward the positive screen 5 and the more positive plate 6 through the meshes of the negative-grid 4. When the oscillator grid 2 is only slightly negative, or even somewhat positive, the virtual cathode 7 has a plentiful supply of electrons available for the modulator section of the tube. When the oscillator grid 2 swings considerably negative, the virtual cathode 7, and hence the modulator plate, are momentarily deprived of their electron supply. This is the "emission valve" mechanism by which modulation is effected in the new tube.

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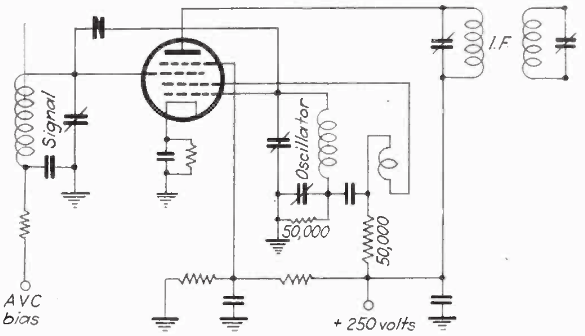
[1] Some of the capabilities of the vacuum tube described in this article are claimed for the new 2A7 and 6A7 tubes which have been announced recently. At the time of writing, however, samples of these tubes could not be obtained.

[2] The term "conversion gain" is used to denote the ratio of intermediate-frequency output voltage to signal-frequency input voltage, as measured from the grid of the modulator tube to the grid of the following tube.

The modulator grid 4 (not the inside grid) is connected to the cap terminal of the tube, and is constructed to have a gradual-cutoff action so that a variable negative bias can be used to control the conversion gain over a wide range without distorting strong signals applied to this grid. It is important that this negative bias has practically no effect on the oscillator behavior, because the modulator grid is incapable of cutting off the major part of the oscillator screen current.

The more important characteristics of the new hexode are given in the accompanying table. In operation, there is a grid leak bias on the oscillator grid, which, taken with the oscillator voltage swing, cuts off all current in the tube more than half the time. This holds the total cathode current down to a small value, which is important in battery-operated automobile receivers.

The figure shows a representative circuit using the new tube. It is now unnecessary to provide any parts for coupling the oscillator to the modulator, since this is accomplished by the emission valve action. The capacitive coupling between oscillator screen and modulator grid sometimes causes appreciable reaction between signal and oscillator tuned circuits. This coupling is readily neutralized by a small neutralizing condenser of about one micro-microfarad, denoted by the symbol "N," which also prevents radiation from the oscillator. An AVC negative bias is shown for controlling the gain automatically, but manual volume control by a cathode rheostat can be utilized with minor circuit changes.



Fundamental circuit of the emission valve

The performance of the new tube in the circuit is proving superior to that of a gradual-cutoff modulator (such as the 58 tube) coupled to a separate oscillator, as a result of the specialized grid functions in the new tube. Using a good intermediate-frequency transformer tuned to 175 kc., the conversion gain of this circuit is 120 times or 42 db.

The theoretical limit of conversion gain is $1/\pi$ times the maximum straight gain of the same tube with the same intermediate-frequency transformer. This limit is closely approached in the emission valve modulator.

The helpful cooperation of the Hygrade Sylvania Corporation in the development of this tube is gratefully acknowledged.

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Radio Engineering Handbook

By 22 authors, edited by Keith Henney; McGraw-Hill Book Company, Inc., New York City, 1933; 583 + X pages; 489 figures, with many charts, tables and bibliographies. Price, $5.

In planning and coordinating a book of such wide scope as that of the present volume, Mr. Henney has accomplished a most difficult task. He has not attempted to produce a text book covering the applied science of radio, but has guided a group of specialists in the completion of a reference volume that will be of peculiar value to the practical designer. Nevertheless, the book is no mere compilation of formulas, tables and similar design material; each of the 22 sections after the first ("Mathematical and Electrical Tables") develops in explanatory form the principal factors involved in a single part of the field. Thus the reader is presented not only with the quantitative relations that he may need to consult from time to time, but also with a running story that shows him the connections between the various fundamentals and many of the ways in which they are being applied.

By first treating the elementary quantities involved in "Electric and Magnetic Circuits," "Resistance," "Inductance," "Capacity" and "Combined Circuits" (Sections 2 to 6) the authors lay a groundwork that is applicable to the more specific problems of the later portions of the book. The two next sections, on "Measuring Instruments" and "Vacuum Tubes" give further underlying information as to two additional and most important groups of what might be called radio tools. Following analytical treatments of "Oscillating Circuits" and of "Detection and Modulation," the balance of the Handbook is divided into sections relating to specific apparatus assemblies such as "Audio Frequency Amplifiers" and "Rectifiers and Power-supply Systems" or to specific services such as "Broadcasting" and "Facsimile Transmission," together with consideration of associated apparatus problems. There are also interesting treatments of "High Frequency Transmission and Reception," of "Photocells" and of the closely allied technology involved in "Sound Motion Pictures."

In any comprehensive and logically arranged book of this type there will necessarily be some duplication of topics treated in the several sections. It would hardly be feasible, for instance, to omit all discussion of power-supply systems or of radio-frequency amplifiers from the portion devoted to "Receiving Systems," merely because both sub-topics are more completely considered in other sections. The editor and the co-authors seem to have struck a creditable compromise as to this difficult problem of book-making, for while it is true that the reader will not always find in a single chapter all that the Handbook has to tell him about a single topic, it is equally true that there is very little duplication in the material presented in the many sections that make up the volume. The index already covers nine double-column pages, and is helpful in locating the discussions of closely related subjects, but could usefully be made even more comprehensive in future editions.

As is pointed out in the preface, each section was written by a specialist selected because of his "expert knowledge of a particular phase of the subject matter," and indeed it would be difficult to find (for example) a man better fitted to discuss short-wave communication than is Commander Taylor, of the Navy Department's Research Laboratory, or one more familiar with picture transmission than is R. H. Ranger. In fact, much credit is due to the several authors, and particularly because each has "stuck to his knitting" and so presented in compact form the set of facts involved in his particular problem. In passing through the book from section to section, one is impressed by an absence of marked differences in style or method of presentation, which, if they existed, would definitely impair the value of the Handbook as a whole. Such unity reflects a praiseworthy cooperation among the authors as well as a good job by the editor.—John V. L. Hogan.

electronics

McGraw-Hill Publishing Company, Inc.
330 West 42d Street
New York City

O. H. CALDWELL, *Editor*

Volume VI —MARCH, 1933— Number 3

Time to turn back to quality

IF a program for stabilization can be carried out by the receiving-set manufacturers, its good effects will be felt all along the line to their parts suppliers as well. A move for higher prices on the part of the set makers would automatically reduce the pressure on the parts makers for lower prices. Instead there would be a demand for better-quality parts to bring better set values, in turn giving the public solid values and higher quality and so fully justifying a higher price level.

Parts prices have been pushed down to an unsound bottom, where operating quality and durability have been seriously impaired. The public interest now lies in stabilizing back to quality.

Designing radios for increased sales

UNDOUBTEDLY the industrial designer is destined to play a more active part in the radio set field than he has in the past. As results of designers' work in increasing sales is demonstrated in other fields, the call will come for more such aid to radio.

But if the designer is to be consulted, he should be called in at the beginning of the job. After the tools have been made, and the chassis form is fixed, the stylist can make only minor suggestions regarding design—changing details or adding decoration and color.

The full benefit of the artist's help can be realized only if he is consulted from the very beginning and urged to co-operate fully with the sales and production departments.

Binaural sound reproduction soon

IT will not be long now, before the subject of binaural or "stereoscopic" sound reproduction will come prominently to the attention of the public and the sound industry. With *two* soundtracks or *two* reproducing circuits, differing in relative intensity as the actors or sources of sound move about on the stage or screen, the listener gets a new sense of perspective. He can, in effect, actually "hear the band march across the field of view," or he can sense the back-and-forth dialog of the actors on opposite sides of the screen. Such binaural hearing gives a new sense of reality and perspective to the picture or play, in place of the flat effect of a single bank of speakers.

Each improvement in realism in the past has meant increased popularity and increased earnings for the industry. Evidently another forward step, both technically and economically, is soon in prospect for sound reproduction.

Exports fall; some countries increase purchases

EXPORTS of radio sets from the United States during 1932 were $13,312,136, a sharp drop-off from the $22,000,000 exports of the preceding year. Yet to forty-three out of the 103 countries to which export sales were made, increases in purchases were registered. These customers whose buying of radio increased, included Belgium, Irish Free State, Holland, Norway, Yugoslavia, Panama, Haiti, Bolivia, Colombia, China, Paraguay, Turkey, Australia, and Morocco.

Loss of $3,000,000 exports to Canada can be ascribed largely to the new Dominion law requiring a percentage of Canadian-made parts in Canadian sets. The quota system in France limited our purchases there. Italy has imposed higher radio-set duties; this limited sales. Britain's departure from the gold standard made purchases in our market too expensive.

Increased broadcasting activity in China resulted in growing imports of American sets. Argentina is now the largest customer for American radios, supplanting Canada, which has dropped to second place.

The case for "clear channels," clearly stated

"THAT portion of the American public which is most in need of broadcasting is the scattered population of our rural and farm communities.

"Service to this group can be given only by high-power stations operating on clear channels. It is vital therefore that continued provison be made for an adequate number of such facilities."

This clear statement by E. L. Nelson, chairman of the committee on broadcasting of the Institute of Radio Engineers, leaves no doubt as to the position of informed radio authorities on the need for clear channels. It is especially timely now when a political movement is on foot to give local urban communities more broadcasting facilities, at the expense of the millions of farm listeners, by "duplicating stations" on clear channels.

NEWS NOTES

A 3,000,000-volt generator is reported from the Metropolitan Vickers Laboratory, Manchester, England. The new high-voltage machine is only five feet in diameter and ten feet high. It contains parallel charged, oil impregnated condensers with all spark gaps segregated in an air column with the air under high pressure.

Television course at Brooklyn Polytech — An evening course in the principles and practice of television will open at the Polytechnical Institute of Brooklyn, March 14. The lecturers will be Dr. A. Ray Olpin of the Bell Telephone Laboratories, and Ivan Bloch, formerly of the Freed Television Corporation, Long Island City, N. Y.

Styling radios for increased sales—To this topic of modern external designs for radio receivers, the National Alliance of Art and Industry will devote its regular clinic luncheon of March 20, at the Hotel White, Lexington Avenue at 37th St., New York City. A number of leading industrial designers will be present, and short talks will be given by merchandising executives and artists.

Crosley's WLW goes to 500 kw.—A contract for the installation of the largest broadcasting transmitter in the world, rated at 500 kw., at station WLW, Cincinnati, owned and operated by the Crosley Radio Corporation, has been awarded to the RCA Victor Company. The 840-ft. vertical steel "radiator" is already under construction at station site, Mason, Ohio, under designs by Joseph A. Chambers, chief engineer WLW.

Urge high-power broadcast stations—High power radio broadcasting is urged, as necessary for satisfactory operation of radio receiving sets and reduction of interference, in a formal report on radio interference just issued by the three electrical bodies—the National Electric Light Association, the National Electrical Manufacturers Association, and the Radio Manufacturers Association. Another report, technical, and for guidance of engineers in measuring radio interference, also was issued.

Higher power broadcasting stations will insure better coverage of the country and should be encouraged by all interested in radio, to improve radio reception, according to the report.

RCA buys DeForest Company's assets—Radio Corporation of America has bid $400,000 in cash for the assets of DeForest Radio Company, now in receivership. The bid has been accepted by the receivers, subject to the approval of the Federal District Court of Newark. One other bid for the company is before the court, that of Hygrade Sylvania Lamp Company, Emporium, Pa. The DeForest Company's statement on March 31, 1932, put total assets $5,034,441. It also has controlling interest in Jenkins Television Corporation.

Exports in 1932. Tubes up, sets down—Despite the general decline in export totals for 1932, radio receiving tubes exported increased both in number and in value. Exports of tubes during 1931 numbered 2,375,048 valued at $1,946,928, increasing in 1932 to 3,758,905 valued at $2,012,656. Exports of radio transmitting sets and parts decreased from $804,524 to $663,750 and receiving sets decreased from $471,263 valued at $14,357,029 to 290,673 valued at $7,321,849. Foreign sales of components (parts) decreased from $3,887,717 to $2,517,287; loudspeakers, 231,085 valued at $1,064,210 to 137,727 valued at $455,840; and other accessories (battery eliminators, aerial kits, aerial eliminators, noise suppressors, etc.) $574,746 to $340,754. Total radio exports for 1932 were $13,312,136, as compared with 1931 exports of $22,635,154.

Radio Tax $1,184,510 in 1932—The five per cent tax on radio sets became effective June 20, 1932, and the Treasury reports that collections from the radio tax ending December 31 aggregated $1,184,510.06. When the excise tax law was passed by Congress the Treasury estimated that the annual receipts from radio and phonograph taxes would be eleven million dollars. The actual returns, therefore, are running about eighty per cent under the estimates of the Treasury and Congress. The 1932 tax collections by months were:

June-July	$32,848.57
August	76,445.47
September	165,710.65
October	218,722.70
November	298,577.86
December	392,204.81

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CHICAGO THEATRE FOUNTAIN

Several Chicago movie palaces have been equipped with photo-cell drinking fountains. When the thirsty approach, iced water gushes forth

REVIEW OF ELECTRONIC LITERATURE

HERE AND ABROAD

Characteristics of gas-filled photocells

[G. A. Boutry, University of Lille]—The anode is a straight wire facing the hemispherical sensitive surface consisting of potassium sensitized by means of a discharge in hydrogen; the cells are then filled with argon at 0.2 mm. pressure (French S cells due to Dunoyer), placed in series with half a megohm and also with 30 meg, and exposed to the light from a tungsten ribbon lamp run at 2,050 deg. K., focused upon the potassium surface. Curves show how the current increases at constant light flux (0.06 to over 1 lumen) when the voltage is increased from 30 to 180 volts and the electrons begin to ionize the argon, and also at constant voltage when the illumination is increased. At 160 volts the current grows from 12 μa. at 0.5 lumen to 17 μa. at 0.54 lumen and to 80 μa. at 0.5405 lumen. In this region, right below the transition to the glow discharge, the sensitivity of the cell is found to have increased when strong currents are allowed to pass (by 1 per cent for currents of 1 μa., by about 5 per cent for 10 μa., and by 200 to 300 per cent for 100 μa.); the current is reproducible only for values lower than these. This latter zone does not appear in spherical cells having a ring-shaped anode (the commercial Fotos cells due to Déjardin); but when a thin layer of potassium is deposited upon magnesium and then sensitized, the stronger currents produce practically no increase in sensitivity.—*Journal de physique 3: 520-536. 1931.*

◆

Selenium cells

[Jm] Details with photograph of the "Rio" photo-cell, entirely metallic, non-vacuum, and capable of directly actuating a sensitive relay without an amplifier.—*Science et la Vie, Paris, December, 1932.*

◆

Barrier-layer rectifier properties

[W. Meyer and A. Schmidt, Osram Laboratory.] A study of the capacity of new and old barrier-layer cells shows that with a dielectric constant equal to ten, the thickness of the barrier layer is about 10 to 100 millionths cm., irrespective of the nature of the cell (copper - barrier - cuprous oxide-copper or copper-barrier-cuprous oxide - graphite, or lead - barrier - selenium-nickel). The capacity is fairly constant when the negative bias applied varies from zero to a few volts. The parallel resistance reaches a maximum when about —0.5 to —1 volt are applied to force electrons through in the obstructed direction. The series resistance has its largest value near zero voltage. All these values vary in an apparently irregular way in the course of the hours during which the rectifier is in use if they were due to space charges changing in time and space.—*Zeits. f. Techn. Physik 14:11-18, 1933.*

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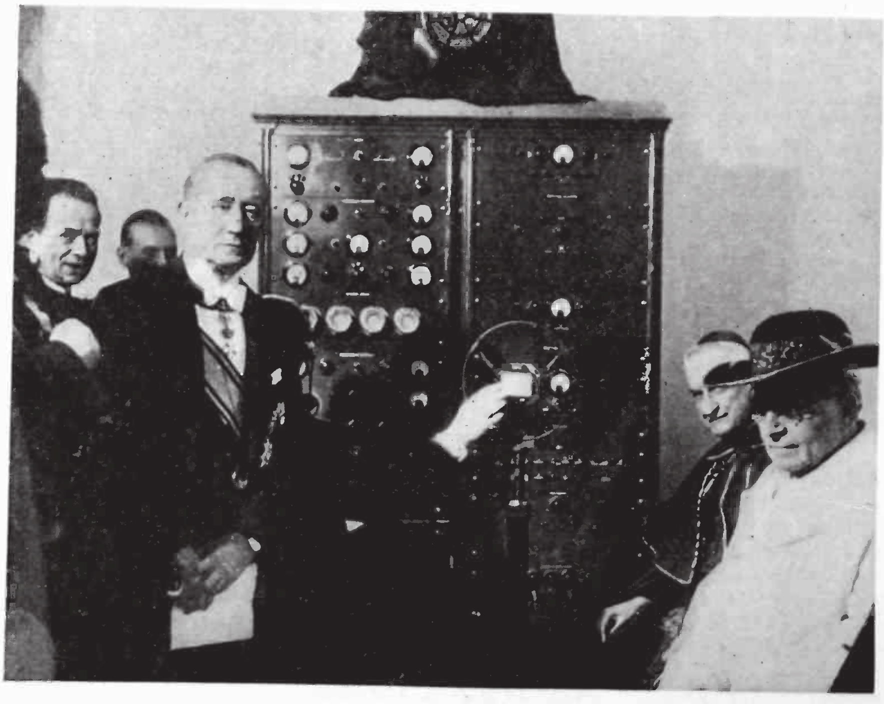
NEW MICRO-RAY CIRCUIT



Senator Marconi and Pope Pius XI at the inauguration of the ultra-short wave link between the Vatican and the Papal Villa 22 miles away.

◆

R-F. coils with and without magnetic core

[H. Fruehauf, Institute of Technology, Stuttgart.] Coils with a magnetic core (to which *Electronics* called attention in July 1931) would require fewer turns, have less damping and need less space. Measurements on various coils (small Ferrocart toroid coil 134 μh., larger toroidal coil 187 μh. with an inner diameter of 19 mm. high and the corresponding straight cylindrical coil 167 μh, screened, 88 turns, diameter 40 mm., height 40 mm.) show graphically that the resistance at resonance of Ferrocart coils in the tuned circuit varies less rapidly with frequency than does that of plain r-f coils (variation 1.35 in place of 2 or 3). Provided that the tuning condenser is not chosen very small, the Ferrocart coils show less damping and give therefore more selectivity than the air coils. The core material is a fine dust of one of the highly magnetic alloys suspended in insulating varnish and spread on thin sheets of paper.—*Hochfr. u. El. Ak. 40: 214-217. 1932. Radio-Helios 9: 89-91. 1932.*

◆

Amplification at r.f. for television

[G. Krawinkel and K. Ziebig] German Post Office. As 10,000 elements and 25 frames per sec. is now current practice, the question is examined whether it would not be easier to amplify the required frequency band of 125,000 cycles as it comes from the photoelectric cell in r.f. rather than in the a.f. stages. The modulation thus obtained would be too small; even with one or two preliminary audio stages, a large amount of r.f. energy would have to be carried through the r.f. stages. The solution proposed is to balance out part of the r.f. current by means of a bridge circuit, and to combine this operation with modulation. High frequency currents are induced in two arms of a Wheatstone bridge formed by coils, the third arm contains the photocell, and the fourth a veriable condenser. The current passed by the bridge is impressed upon a high resistance which is in parallel with the grid of the first r.f. tube. The last amplifier tube is used in a detector circuit.—*Ferns, Tonfilm, 3:221-227, October-December, 1932.*

◆

A simple resonant a-f amplifier

[M. Pawley.] In communication networks in radio control of airport lights and in seismic prospecting selective amplifiers are used to discriminate against frequencies below or above a certain pitch. By adding a variable resistance r (1/10 to 1 meg.) in series with the primary inductance l, and a variable condenser C (0.002 μf.) in parallel with the secondary coil L of the resistance R, neglecting distributed capacity effects and assuming constant permeability and making rL much larger than Rl, only the band between the frequency at which C resonants together with L, and that at which C and the leakage inductance $lL - M^2$ give resonance is amplified. Experiments with a commercial type of transformer show that for a fixed load capacity of 0.006 μf, for instance, an increase in the primary resistance from 6,000 to 100,000 ohms sharpens the peak without shifting the frequency—*J. Franklin Institute 215:133-147, 1933.*

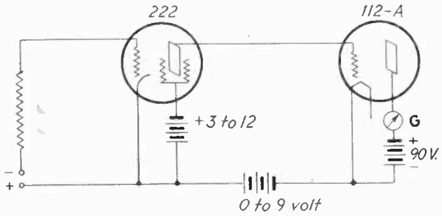
◆

Surge impedance and impedance of transmission lines

[A. Clausing.] Siemens and Halske, Berlin. The fight against radio noises which travel long distances along transmission lines is all the more difficult as the laws of propagation of high frequency currents along actual transmission lines have not been made the subject of experimental study. Tests made at the request of a commission on radio interference show that the theoretical formula for the surge resistance (equal to the square root of the product of short circuit by open circuit impedance) probably applies, but that these impedances tend towards infinity at intervals of 38 kc. on a two-wire 2 km. transmission line so that in order to get results within 1 or 2 per cent, a large number of observations and extremely stable r-f sources are required. Measurements in the range of 0 to 800 kc. on a 2 km. line consisting of two copper wires of 3 mm. diameter gave a surge impedance of about 600 ohms.—*El. Techn. Zeits. 54:54-56, 1933.*

D.C. amplifiers

[P. A. Macdonald and J. T. Macpherson. A. H. Taylor and G. P. Kerr.] Although the FP-54 and similar tubes are available for d.-c. amplification, with a grid input resistance of 10^{16} ohms and a grid current of 10^{-15} amp. approximately, the insulation of the e.m.f. itself does not always warrant their use. A circuit is described in which the input current is forced through a 1,000 meg. resistance between the control grid and the filament of a 222 tube which has 3 to 12 volts on the screen grid, whereas the plate is left floating, that is allowed to be charged up by the electrons accelerated by the screen-grid. The plate is directly connected to the grid of the following stage, a 112-A tube, but a source of potential of a few volts is inserted in the line connecting the negative ends of the filaments. The higher the grid voltage of the first tube, the higher the negative charge on the plate and the following grid and a linear relation with a slope of about 3×10^{-4} volt per mm. is obtained between the plate current of the 112-A tube (90 volts) and the grid voltage of the first tube.



The second article describes a portable amplifier containing two 859 tubes for use with a cadmium photoelectric cell, but no definite results are given. —*Phil. Mag. and J. of Science 15: 72-81, 1933. Review Scient. Instruments 4:28-32, 1933.*

◆

Micro-radio waves

Address by Marconi at a meeting of the Royal Institution. Fifty-cm. waves were obtained with the aid of the well-known Barkhausen positive grid circuit, their strength being greatly increased when using two tubes in parallel in a completely symmetrical circuit, the wires connecting the two plates, the two inner neighboring ends of the four ampere filaments, and the wires connecting the outer terminals being each tuned to that wavelength. The oscillations start as soon as the saturation of the grid-current is reached, and rapidly increase to a maximum as the heating current is increased. The radiated energy of one unit is 3.5 watt, the over-all efficiency, 6 per cent. With a receiver built according to the same principle, the circuits being formed of telescoping tubes, telephone conversation was good over a distance of 22 miles so that the Vatican decided to adopt the new system between the Vatican City and the Palace of the Pope at Caskel Gandolfo (see *Electronics*, July, 1932). At close to 60 miles the voice appears weak or fades in and out; sometimes there is a return to good signal strength around 90 miles. Conversation cannot be carried out beyond 120 miles with 4 watts on 50 cm.—*The Electrician. 110: 3-6. 1933.*

◆

Matching short-wave feeder lines

[S. Issakowitsch, Heinrich Hertz Institute, Berlin.] The lines (single or parallel or concentric) connecting the oscillator circuit to short-wave antennas placed as high as possible are often several times longer than the wavelengths themselves, and losses due to interference between the outgoing and the reflected waves are liable to occur. The generator (G.M. waves) yields maximum energy when the load resistance (composed of coupling transformer, feeder line and antenna) is equal to $a + jb$, and its own internal resistance is equal to $a - jb$; where R, the square root of $a^2 + b^2$ is a few thousand ohms whereas the feeder line used represents only about 500 ohms. For best results the resistance behind the primary of the coupling transformer must then be equal to R, and the resistance ahead of the secondary equal to 500 ohms. The resistance of the antenna must also be made ohmic and equal to 500 ohms. It is possible to satisfy all the conditions fairly completely as shown by experimental tests. —*El. Nachr. Techn. 10:9-19, 1933.*

◆

Photoelectric counters for visible and ultra-violet light

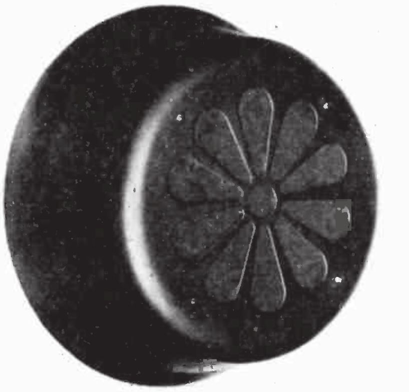
[G. L. Locher, Bartol Research Foundation, Franklin Institute.] Low leakage tubes as developed by G. E. and Philips permit the counting of 20 to 30 electrons at a time. The ideal would be to have an instrument indicating single electrons as soon as they are set free, for instance, when a very faint light falls upon a metallic point. The author describes an experimental gas-filled photocell with a three-fourths-cylindrical cathode carrying the photosensitive surface on its inner side (length 11 mm. diameter 7 mm.) and a tungsten or platinum wire anode from 0.038 mm. to 0.11 mm. in diameter. On applying from 600 to 2,000 volts between anode and cathode, the photoelectric effect is amplified by ionization in the gas, and with the aid of a high-gain amplifier records of about 30 individual electrons per second are obtained mixed, however, with and undistinguishable from natural ionization effects. — *Physical Review 42: 525-546, 1932.*

+ NEW PRODUCTS

THE MANUFACTURERS OFFER

Auto speaker housing

The Hawley Products Company, St. Charles, Ill., announces that it is now in position to furnish a moulded case of special acoustical material which combines all of the advantages of wood and metal without the defects of either. It is of one-piece construction containing no seams. The front is provided with a metal grille and dust-proofing grille cloth. It is designed for mounting of standard speakers using the single stud or similar mounting method of attaching to the dash.



Acoustically the response from the speaker is felt to be comparable, if not superior, to a good wooden case. A very marked superiority in tone should be noticed in comparison to a metal case, it is declared.—*Electronics, March, 1933.*

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Tube adaptor

The Alden Manufacturing Company, 715 Center St., Brockton, Mass., has a new 965AC adapter which enables out-of-date equipment to test the new 25 and 30-volt tubes. With this 965AC adapter the 48 tube having a 30 volt heater can be checked in the 27 socket of any tube checker by using an ordinary 60 watt 115 volt lamp in the series lamp socket. This same adapter checks the 43 tube having a 25 volt heater, in the 27 socket of any tube checker by using a 40 watt 115 volt lamp.

The 965-25Z5 adapter checks separately both plates of the new 25 volt double plate heater-type rectifier tube used in the latest universal and "transformerless" sets. The list price of each adapter is $2.50.—*Electronics, March, 1933.*

Infra-red filter glass

A new colored optical glass filter has been developed by the Jena Glaswerk Schott & Gen, Germany, and sold in this country by Fish-Schurman Corporation, 230 East 45th St., New York City. This material is called RG-9 and cuts out nearly all the visible spectrum but passes the infra-red, being developed especially for electronic applications using the caesium photcells, for burglar alarms, and other places where an invisible beam is desirable.

An interesting catalog of Jena glasses (written in German) giving transmission characteristics of many colored filters may be obtained from the American agents. According to the agents these Jena filters are stable in transmission and absorption and their accurately measured characteristics provide quantitative data useful to engineers employing the material. This particular material is available in sheets, bulbs and other forms.—*Electronics, March, 1933.*

◆

Paper-dielectric condensers

A Complete Line of high-grade paper dielectric condensers produced by Wego Condensers, Inc., of 729 Seventh Ave., New York City, is available in a range of capacities and sizes from 200 volts up to the large 7,000-volt transmitting condensers.

Leon L. Adelman, vice-president, points out that the Wego line of condensers was first introduced twenty years ago, back in 1913, and that since the factory has been specializing in condensers alone, the product is of superior quality and excellence.—*Electronics, March, 1933.*

The editors of Electronics *are continually being asked for the names of suppliers of various products entering into the use of tube circuits for communication and industrial purposes.*

As of Jan. 1, our catalog files are being revised and manufacturers are requested to forward to Electronics *their latest catalogs.*

At the same time, descriptions and cuts of new apparatus will be welcome.

Portable phonograph

The Ansley Radio Corporation, 147 West 23rd St., New York City, has extended its experience in a-c-d-c radio manufacture, to the new Ansley a-c-d-c portable Dynaphone, a universal phonograph unit which includes the following features: Four-tube amplifier using one 37, two 89's in push-pull and one 80. The change from a.c. to d.c. is made by a simple plug arrangement. Individual tone and volume controls. Magnavox dynamic speaker. High-quality electric pickups. Cover which may be closed over record while playing. Record compartment in cover. The case measures 20 by 14 by 8½ in, and the weight complete is 30 lb. Price $69.50. —*Electronics, March, 1933.*

◆

500-watt projection lamp

A New Mazda Lamp of 500 watt, 100-volt rating, has just been perfected by the G.E. National Lamp Works, Nela Park, Cleveland, Ohio. So far, the only 16-mm. projector to be offered with this powerful new lighting equipment is the Victor Model 10FH Premier Hi-Power. The Victor 10FH was first announced early in November and was originally equipped with the 400 watt-100 volt G.E. Lamp. According to a statement issued by the Victor Animatograph Corporation, Davenport, Iowa, the Model 10FH, which has built-in lamp resistance in the base, will accommodate the new 500-watt lamp without alterations of any kind.

As the 500-watt lamp gives even too much light except for very large pictures, long throws and daylight projection, Victor will continue to supply the 10FH with 400-watt lamp except when the 500-watt is specified.—*Electronics, March, 1933.*

Microvolter

The Ferris Instrument Corporation, Boonton, N. J., announces a new microvolter, which operates from the a.c. line, and covers a frequency range of 150 to 20,000 kc. It is designed for factory and field testing of receivers, and also for laboratory use to supplement larger signal generators.

It is compact and readily portable, and weighs approximately 20 lb., ready for use. The case is constructed of welded sheet aluminum, and has an attractive and durable black wrinkle finish.

Triple shielding is used to prevent "leakage." The radio frequency oscillator includes 6 coils, the desired one being selected by a knob on the front panel. A shielded resistance type attenuator is used, with a vacuum tube voltmeter at its input terminals. The output resistance is 5 ohms for outputs up to 1,000 microvolts. Modulation is fixed, 400 cycles, 30 per cent, and can be switched on or off.

An unusual feature of the design is the accessibility of the r-f coils, any one of which can be quickly replaced at any time a special range coil may be desired.—*Electronics, March, 1933.*

✦

Cord-type resistors for a.c.-d.c. sets

D. T. Siegel, general manager, Ohmite Manufacturing Company, 636 N. Albany Ave., Chicago, Ill., announces that his company is now manufacturing a new type of resistance unit for use on a.c.-d.c. radio sets which eliminates from the set the heat produced by the voltage reduction needed for the tube filaments.

This resistor, known as the Cordohm, is being manufactured by Ohmite under exclusive license from the Stewart-Warner Corporation. The unit, which looks much like ordinary lamp cord, consists of three wires, two copper and one resistance wire, all wound in the same cord. The two copper wires furnish the 110-volt circuit and the resistance wire lead furnishes reduced voltage for the filament circuit. One end of the unit is connected to a soft rubber connection plug.

The Cordohm is furnished in several standard resistance values adaptable for use on four and five-tube sets. Because the resistance unit runs the entire length of the cord, the generated heat is easily dissipated and the cord does not become more than moderately warm. —*Electronics, March, 1933.*

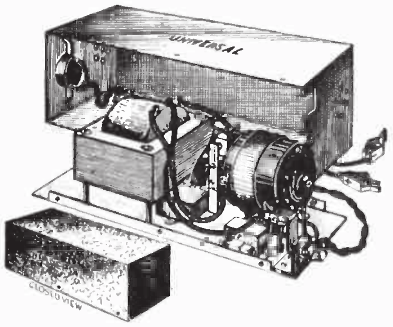
✦

Battery converters

The Universal Microphone Company, Ltd., Inglewood, Calif., has developed a line of battery converters for delivering 110 volts alternating current from storage-battery supply. These converters are adapted for the operation of any 110-volt alternating-current device, particularly sound amplifiers for trucks, parks, neon signs, and all portable uses in places where commercial current is not available.

The Model 60 converter operates from 6 volts direct-current, and has an output of 60 watts. The battery drain is 90 watts, and the price is $28.

The Model 150 converter operates from 12 volts, and has an output of 150 watts. The battery drain is 216 watts (12 volts, 18 amp.) and is sufficient for the operation of three-stage sound amplifiers terminating in two 50 tubes in push-pull, and in addition will operate an ordinary 20-watt turntable and power-speaker field. This model is priced at $60.



Howard F. Smith, 142 Liberty St., New York City, is eastern representative for the Universal Microphone Company.—*Electronics, March, 1933.*

✦

Low-voltage relays

The Guardian Electric Manufacturing Company, 1522 Adams St., Chicago, Ill., offers the designer of control equipment a special high-speed service in the shipment of relays, both of standard and special design.

A complete stock of many thousand individual parts is maintained, and a special engineering staff is available to fabricate relays immediately to meet all circuit requirements.

This service, together with the specialized experience of Guardian engineers in relay circuit design, offers a certain solution to control problems.

Guardian relays are precision devices of rugged construction, designed for millions of operations without attention. Perfect operation at low voltages and on small currents has been secured by the development of unusual designs, employing magnetic materials having the higest possible permeability and lowest retentivity. The design of the magnetic path is such as to have extremely low reluctance, and to effectively utilize all the flux set up by energizing the coil windings.

These coils are wound with the best grade of insulated magnet wire. A wide range of coil resistance values from a fraction of an ohm to thousands of ohms, are available to permit the employment of actuating currents from 0.5 milliamperes to 5 amperes.—*Electronics, March, 1933.*

✦

Moving-coil microphone

The Thomaston Laboratories, Inc., 135 Liberty St., New York City, is marketing a new moving-coil permanent cobalt-magnet electrodynamic microphone which has many advantages in use. It is small, and does not hide the face of the speaker, its angle of inception is wide, permitting non-directional use over an area covered by 135 degrees in all directions. The unit is without background noise, permitting unlimited amplification for distant pick-up or for amplification of signals far below human audibility. This TomLab MC30, as it is called, requires no battery or other power to operate it. Simply run a twisted pair of wires, and this 30-ohm line can be operated 1,000 ft. without distortion. The pre-amplifier need not be located near the microphone. The price is $125.—*Electronics, March, 1933.*

✦

Heat-resistant moisture-proof insulation

Alsimag is the name of a new material developed by the American Lava Corporation, Chattanooga, Tenn., which has high insulating qualities, is heat resistant, has low moisture absorption, is non-corrosive, and has low loss factor at high frequencies. Other qualities are its durability, hardness, strength, accuracy and resistance to alkalis and acids.

Alsimag is formed by extrusion in the form of rods, bars, cylinders, flats, etc. It is also pressed accurately to size and shape, in most cases to final dimension. After forming by extrusion or pressing, it is still possible to machine Alsimag before the final hardening process. Alsimag parts may be turned, threaded, drilled or milled to produce intricate shapes. Such parts may also be glazed with white or colored glazes. Being finally kilned at 2,500 deg. Fahr., no subsequent alterations by grinding or machining can be carried on by the user. Complete technical data are available on request.—*Electronics, March, 1933.*

Airport receiver

Lear Developments, Inc., 847 W. Harrison St., Chicago, Ill., announce their new Radio-Aire airport radio receiver which is now in production.

This receiver is a distinct departure in a long-wave set covering the entire frequency band of 235 to 720 kc. It is a portable radio of special interest to airports, hangars, pilots, aircraft officials and everyone interested in aircraft operation. It enables air enthusiasts to keep in touch with weather conditions, naval communications and also to enjoy entertainment program broadcasts.

It is self-contained, all electric, a.-c. operated, with full dynamic speaker. Especially built for commercial demands, it is of extremely high quality and dependability, and is not to be confused with ordinary radios.

The tone quality on the entertainment broadcast range matches the finest home radio. Litz wire, low loss, high gain inductances invented and developed by Lear, permit the wide tuning range, high sensitivity and sharp selectivity. The list price is $89.50.—*Electronics, March, 1933.*

◆

Moulded paper-pulp diaphragm

The United Press Products Company, 400 West Erie St., Chicago, Ill., has developed a moulded-paper pulp diaphragm, which is remarkably accurate in its production of music and speech. The cone construction is seamless, with the voice collar and suspension integral with the cone proper, which eliminates all seams of the old type cone design, distortion, noises, lack of uniformity, and chance of seams opening up during performance.

A new, automatic process of manufacturing these cones has been developed, in which all the elements of make-up of the cone are under control. The mass, or weight, of cone can be varied by adjustability in the machinery, and the cone can be brought to any desired weight, and so maintained in production to within small limits of variation. Even the most delicate cones can be produced.

The second element of importance is the control of paper pulp by formula. Various combinations of pulp and chemicals can be combined and maintained to give any degree of softness or hardness, which reflects itself in the low and high frequencies. Any special design can be moulded and then pressed to any degree of hardness. Control through adjustability can be had in the process to give a greater flexibility to the suspension, as compared with the cone proper. Other incidental points of control in the process permit the manufacture of the most desirable characteristics for any individual speaker design. — *Electronics, March, 1933.*

◆

Self-tapping screws

The Kellogg Switchboard and Supply Company, 1066 West Adams St., Chicago, Ill., has developed its Tapster screws for assembly purposes wherever the fastening of metals, bakelite, slate, fibre, ebony-asbestos, and similar hard materials is involved. The feature of this new screw is its own pair of cutting edges which tap out the thread ahead of the screw and so make a very snug fit, compared with ordinary machine screws in tapped holes. This gives the whole assembly greater strength in resisting vibration, shear and stress, according to the manufacturers. The new Tapster screw with balanced flutes can also be used in many places where the usual self-tapping screw which merely pushes the metal aside would not be adaptable, it is declared. Tapster screws are made in various standard-thread types, and can be retracted and re-driven without injury to themselves or the threaded holes. Use of screws of this kind may save from 40 to 75 per cent of the cost of assembly operations. — *Electronics, March, 1933.*

◆

Full-wave converter and time-delay unit

The New Webster Full-Wave Converter and time-delay unit combines efficiency and reliability in automobile B eliminator supply because it is a combination interrupter and rectifier in one unit. There is no need for further rectification, therefore the rectifier tube, and its attendant losses are entirely eliminated from the design. Because of the self-rectifying features, a high order of regulation can be maintained. The primary and secondary contacts are so synchronized to reduce sparking to an absolute minimum. Efficiency in excess of 60 per cent is easily obtainable. An automatic time-delay device, which delays application of the B supply voltage until the tubes in the radio set attain operating temperature. In its present form, the Webster full-wave converter and time-delay unit is made as a replaceable unit, replacement being as simple as changing a tube. The unit is hermetically sealed in a bakelite housing. It can be furnished for operation on either 6 volts, 12 volts or other voltages. Made by the Webster Company, 3825 W. Lake St., Chicago, Ill.—*Electronics, March, 1933.*

◆

Portable and pocket-type instrument

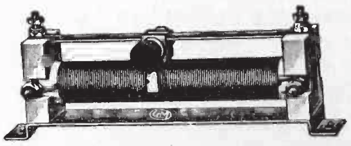
The Roller-Smith Company, 233 Broadway, New York City, announces a new line of Steel-Six portable instruments. The outstanding features of these instruments are their steel cases, which are very rugged and which shield the mechanism against the effect of external magnetic influences; usually long scales; high accuracy; open and well lighted dials; fusing when desired; a very complete line, comprising direct current ammeters, milliammeters, voltmeters, millivoltmeters and volt-ammeters and alternating current ammeters, milliammeters, voltmeters, single and polyphase wattmeters, frequency meters and power factor meters.

The HTA and HTD small, pocket-type portables, which were taken off the market some time ago, are now being reinstated on account of an insistent demand for a complete line of small portable instruments for miscellaneous applications. The line includes direct current ammeters, milliammeters, voltmeters, millivoltmeters and volt-ammeters and alternating current ammeters, milliammeters and volt-ammeters.—*Electronics, March, 1933.*

◆

Slide-wire rheostat

A small, high quality, inexpensive slide-wire rheostat for radio experimenters, and manufacturers of electrical equipment is announced by G-M Laboratories, Inc., 1735 Belmont Ave., Chicago, Ill., in their type R rheostat. Wound on a one-piece porcelain form, with adjustable contact for varying the resistance, this unit is designed for maximum service and convenience. It will dissipate 75 watts continuously.



These rheostats are wound with wire having low temperature coefficient of resistance, and can be supplied in 12 ratings from 5,000 ohms, 0.12 amperes to 4.8 ohms, 4 amperes. Binding screws at each end of the winding permit the use of any type R rheostat as a potentiometer. Considerable overloading for brief intervals will not permanently damage the rheostat. — *Electronics, March, 1933.*

U. S. PATENTS

IN THE FIELD OF ELECTRONICS

Electronic applications

Vehicle control. Use of a thermionic tube for controlling the speed of a dynamo electric machine. F. W. Godsey, Jr. The Safety Car Heating & Lighting Co. No. 1,896,169 and No. 1,896,170.

Rail testing. Testing rails by creating a magnetic field about the specimen by passing current through it, positioning a magnetic body in the created field so as to have its permeability affected. Theodor Zushlag, Magnetic Analysis Corp. No. 1,896,737.

Generator control. Method of using a light sensitive cell for controlling the speed or voltage of a generator. No. 1,896,547.

Watthour meter testing. Method employing electron tube. D. S. Schnell assigned to W. E. & M. Co. No. 1,896,755.

Automatic dimming device. A light-sensitive method for automatically dimming the lights of an automobile when approaching another car. Joseph Gyster, Rochester, and E. Wildhaber, Brooklyn, N. Y. Filed Aug. 28, 1928. No. 1,881,521.

Measuring the thickness of paper. The method shines light through the paper into a light-sensitive cell whose current is amplified and used to run an indicator. Frank Sawford, Vancouver, B. C. Filed Nov. 19, 1928. No. 1,882,962.

Determining the moisture content and quality of material. A condenser, the dielectric of which consists of the material whose quality is to be measured, is connected to an oscillator and a rectifier. Variations in current passing through the rectifier give an indication of the quality of the material. J. D. Clarke, Kensington, England. Filed April 28, 1927. No. 1,878,109.

Color analyzers. Method of automatically throwing on a standard and on a sample light of different colors and recording the comparative output. C. W. Stone assigned to G. E. Co. No. 1,894,132. Filed August 10, 1931.

Reproducing system. Combination of a light sensitive device and a modulating means for transferring light impulses to an acoustic system. W. L. Dawson assigned to B. T. L. Inc. No. 1,894,023.

Electrical musical instruments. A series of patents granted to John H. Hammond, Jr., on the regenerative piano. No. 1,893,940; piano with loud speaker on secondary sound board. No. 1,893,893; piano with three action loud speaker, No. 1,893,892.

Speed regulation. Method of using tubes for regulating the angular velocity of a shaft. Comprising a direct current generator, a second generator which acts as a break dynamo, both generators being coupled to the same shaft and an amplifier. The first generator is connected to the input of the amplifier and the field winding of the second generator is connected to the output of the amplifier. M. J. Jansen, R. Vermeulen, N. A. J. Voorhoeve assigned to M. G. Philips. No. 1,894,562.

Electrical translation circuits and regulators. A series of patents granted to A. F. FitzGerald and others assigned to G. E. Co., on the use of electron tubes for translating energy from one circuit to another or for controlling circuits. Patent Nos. are 1,893,766; 1,893,772; 1,893,767; and 1,893,768; 1,893,771; 1,893,760; 1,893,780; 1,893,781; 1,894,079; 1,894,078, and 1,894,114.

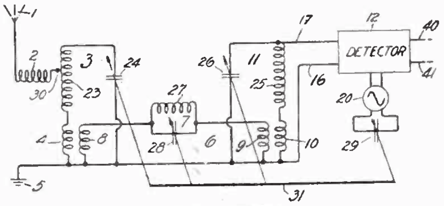
Generation, Detection, Etc.

Modulation system. A two-grid tube, one grid of which is controlled by a quartz crystal, modulation going into the other grid. J. A. Willoughby, Cambridge, Mass. Filed December 18, 1928. No. 1,896,268.

Phase multiplier. Method of using cathode-ray tube for multiplication of phases. August Hunt, Wired Radio Inc. Filed November 20, 1930. No. 1,896,747.

Neutralizing circuit. Method of eliminating capacity coupling. H. A. Wheeler assigned to Hazeltine. Filed September 22, 1924. No. 1,896,500.

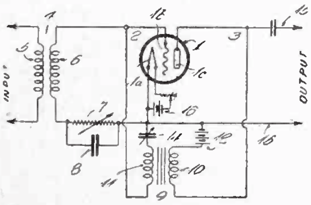
Selector circuit. A pre-selector circuit for a superheterodyne. H. T. Budenbom assigned to B. T. L. No. 1,896,065.



Modulating system. Plate-circuit modulation is used and the modulated output taken from the screen grid of a tetrode. Russell S. Ohl, assigned to B. T. L. No. 1,896,785.

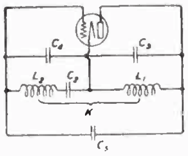
High frequency generator. Device for producing high frequency waves comprising a pair of stationary plates, a filament between the plates, and external inductance in the circuit of the plate. Karl Kohl, Erlanger, Germany. Filed September 17, 1927. No. 1,896,958.

Frequency division. Method of deriving currents of a sub-multiple frequency. Robert M. Page, Washington, D. C. Filed March 13, 1931. No. 1,896,417.



Modulation system. A three-grid tube, one grid of which carries the incoming signal, the second of which acts as a space charge grid, the third of which acts as a modulating grid. F. B. Llewellyn assigned to B. T. L. Inc. No. 1,896,780.

Constant frequency oscillator. A frequency determining circuit relating to input and output circuits, and a frequency stabilizing reactance. F. B. Llewellyn assigned to B. T. L. Inc. No. 1,896,781.



Radio Circuits

Selective amplifier. A series resonant output circuit including a resistor having a value approximately equal to that of the tuned circuit resistance at signal frequency. A. S. Riggs. No. 1,893,563. Filed June 8, 1929.

Radio frequency amplifier. A plate circuit neutralizing amplifier in which both the secondary capacity, secondary inductance as well as the mutual inductance can be varied. Lincoln Walsh assigned to Hazeltine. No. 1,894,503. Filed September 26, 1927.

Radio amplifier. A conventional amplifier in which the secondary capacity is tuned simultaneously as the capacity coupling between primary and secondary is varied. J. M. Avery, assigned to R. C. A. No. 1,894,578. Filed July 13, 1925.

Double action volume control. Variation of a resistance shunts the antenna to ground circuit and at the same time affects the grid bias of the R. F. tubes. Alexander Senauke assigned to King Mfg. Co. No. 1,894,794. Filed July 3, 1929.

Superheterodyne receiver. Method of maintaining constant frequency difference between the frequencies of the receiving circuit and the local oscillation generating circuit. Lucien Levy, Paris, France. Filed October 3, 1927. No. 1,893,779.

Superheterodyne system. A method of radio receiving comprising tuning the antenna systems at a given frequency, generating local oscillations at the frequency of the incoming oscillation, generating local oscillations at a second varying frequency, superimposing said local oscillations on the first local oscillation, combining the composite oscillations thus produced and the incoming oscillations by demodulation to produce a beat frequency and rendering audible the oscillations thus produced. Lucien Levy, Paris, France. Filed Oct. 3, 1927. No. 1,888,536.

Wave signalling system. A resonant apparatus that is stable but has less damping than is usual for true reproduction so that oscillations tend to persist therein after the signal ceases in combination with means for rhythmically altering the phase of the energy in the said resonant apparatus at a frequency lower than the carrier frequency of the received energy and higher than the highest modulation frequency of the received energy in order to subdue the persisting oscillations in the resonant apparatus. James Robinson assigned to British Radiostat Corp. Ltd. Filed July 30, 1929. No. 1,889,293.

BRITISH PATENTS

IN THE FIELD OF ELECTRONICS

Electron Tubes

Cold cathode tube. An amplifier with a glow discharge acting as cathode has a grid additional to the control grid. Electrons from the whole cathode can pass freely to the other electrodes. The grid may be biased negatively or positively and the gas pressure may be such that little or no ionization by collision occurs in the space between the control grid and the amplifier anode. Telefunken. No. 377,540.

Light sensitive cell. A light sensitive substance separated by a layer of less thickness than one mm. containing one or more solid substances insulated from the other electrodes. The cell will operate without the application of a potential between the electrodes. The substance may be caesium, barium or other alkali or alkalin earth metal. The separating layer may be the oxide or other compound of one of the electrodes and the photo-electric substance is preferably very thin and adsorbed in the separating layer. The resistance of the separating layer may be reduced by incorporating with it articles of conducting material such as tungsten.

In one cell a plate of zirconium, the surface of which is oxidized to form a thin insulating layer, is used with caesium which is admitted from a mixture of caesium chromate and a reducing agent such as zirconium, the metal being deposited as a layer on the insulating layer. Philips, Holland. No. 378,451.

Filamentless tube. Tube designed for amplifying purposes with a glow-discharge electron source maintained in a rarified gas. Telefunken. No. 374,889.

Television

Scanning system. Method in which a scanning beam is moved across the picture with a velocity which is varied automatically in accordance with the fineness of structure of the portion of the picture being scanned at any instant. R. Thun, Germany. No. 377,175.

Television receiver. Method of projecting the cathode ray picture onto a mirror so that a number of persons may view the picture at the same time. V. K. Zworykin, Marconi Co. No. 377,622.

Discharge lamp. Glow-discharge tube for television purposes. H. W. Weinhart, assigned to E.R.P.I. No. 375,407.

Television system. In a television or picture telegraph receiver comprising a cathode ray tube in which a ray of electrons is directed on a structure and is deflected so as to scan the picture area, means are provided for increasing the velocity of the electrons at a point in the path of the ray shortly after the point at which deflection is effected, and a substantial distance from the end wall of the tube, whereby the greater part of the path of the ray is traversed by electrons at high speed, while the deflection is effected while the electrons are moving at a relatively low speed. The ray is developed from an electron gun. The antenna circuit is coupled to amplifying circuits, the output of which is connected through filters 25, 26 and amplifiers to supply scanning frequencies to coils 28, 29, arranged to cause deflection of the ray 12 in two directions at right-angles. The picture impulses are impressed on the primary winding of a transformer 27. A second anode in the form of a cup-shaped structure 31, made of fine wire mesh, is disposed in the tube 10 with its open end extending toward the electron gun 11 and in contact with a silver coating formed on the interior of the tube between the lines 33, 34. The bottom 35 of the structure 31 forms a screen through which the electrons pass to the end wall of the tube. In the form shown in Fig. 1, this end wall is coated with a thin transparent layer of silver or other conducting material supporting a fluorescent screen 14; a thick coating of silver 37, in the form of a ring, overlaps the edge of the thin layer and serves to connect the same to a battery or other source of high potential 39. The screen 35 and structure 31 are maintained at a high potential intermediate between that of the anode 18 and the fluorescent screen. In operation, the resultant field of the coils 28, 29 deflects the ray 12, as the electrons are emitted from the gun, at a relatively low velocity determined by the potential of the anode 18. As soon as the electrons pass beyond the influence of the coils their velocity is accelerated under the influence of the second anode 31, and they reach the screen 35 while traveling at a high velocity. The velocity is further increased between the screen 35 and the fluorescent screen, causing the production of a very bright spot at the point where the ray strikes the latter, the brightness being further increased by secondary emission from the screen 35. The image developed on the screen 14 may be projected through a lens system 42 to an observation screen 43. In a modification the fluorescent screen is replaced by a Wehnelt window, the electrons passing through which may be made to fall on a photographic plate or film. In Fig. 5 the distance between the screen 35 and the fluorescent screen 14 is increased, to minimize difficulties in insulation, and a focusing coil 47 is arranged about the tube between the screens. A water jacket 48, with inlet and outlet connections 49, 50, may also be arranged on the end of the tube. The velocity of the electrons between the screens 35 and 14 may be increased in a series of steps by the provision of additional anodes at intermediate points. V. K. Zworykin, Marconi Co. No. 381,306.

Radio Circuits

Audio compensation. In a system in which variation in tuning varies the attenuation of the side band frequency, a control is provided in the audio amplifier to correct for such attenuation and is operated with the tuning control. C. E. Dean assigned to Hazeltine. No. 378,733.

Short wave oscillator. A valve whose intermediate electrode is at a positive potential relative to the other electrodes and a catalyst element either inside or outside the valve and comprising a low loss tuned metallic circuit coupled by capacity to the valve electrodes to aid in starting and maintaining of very high frequency oscillation. N. E. Lindenblad, Marconi Co. No. 379,126.

Audio compensation. A receiver is arranged to have a constant selectivity which produces side band distortion and is provided with an audio frequency amplifier arranged to correct for the distortion produced by the side band attenuation of frequencies remote from the carrier. R. A. Braden, Marconi Co. No. 379,195.

Super-regenerative receiver. The quenching oscillations are generated by reaction between the input electrode *G* to the receiving valve and an output electrode *F* additional through the electrode *P* and *G* which provide the high frequency reaction. J. Croysdale and S. R. Wright, Cheshire, England. No. 379,426.

FIG. 1.

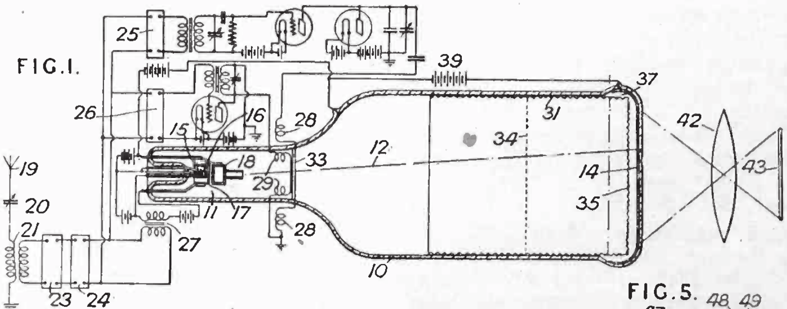
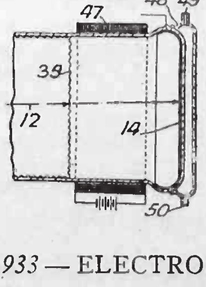


FIG. 5.



electronics

radio, sound, communications and industrial applications of electron tubes • • • design, engineering, manufacture

New styles for radio sets

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Tubes for detector-output

◆

Back to quality in radio

◆

Single-tube inverters

◆

Manufacturing electron-tube equipment

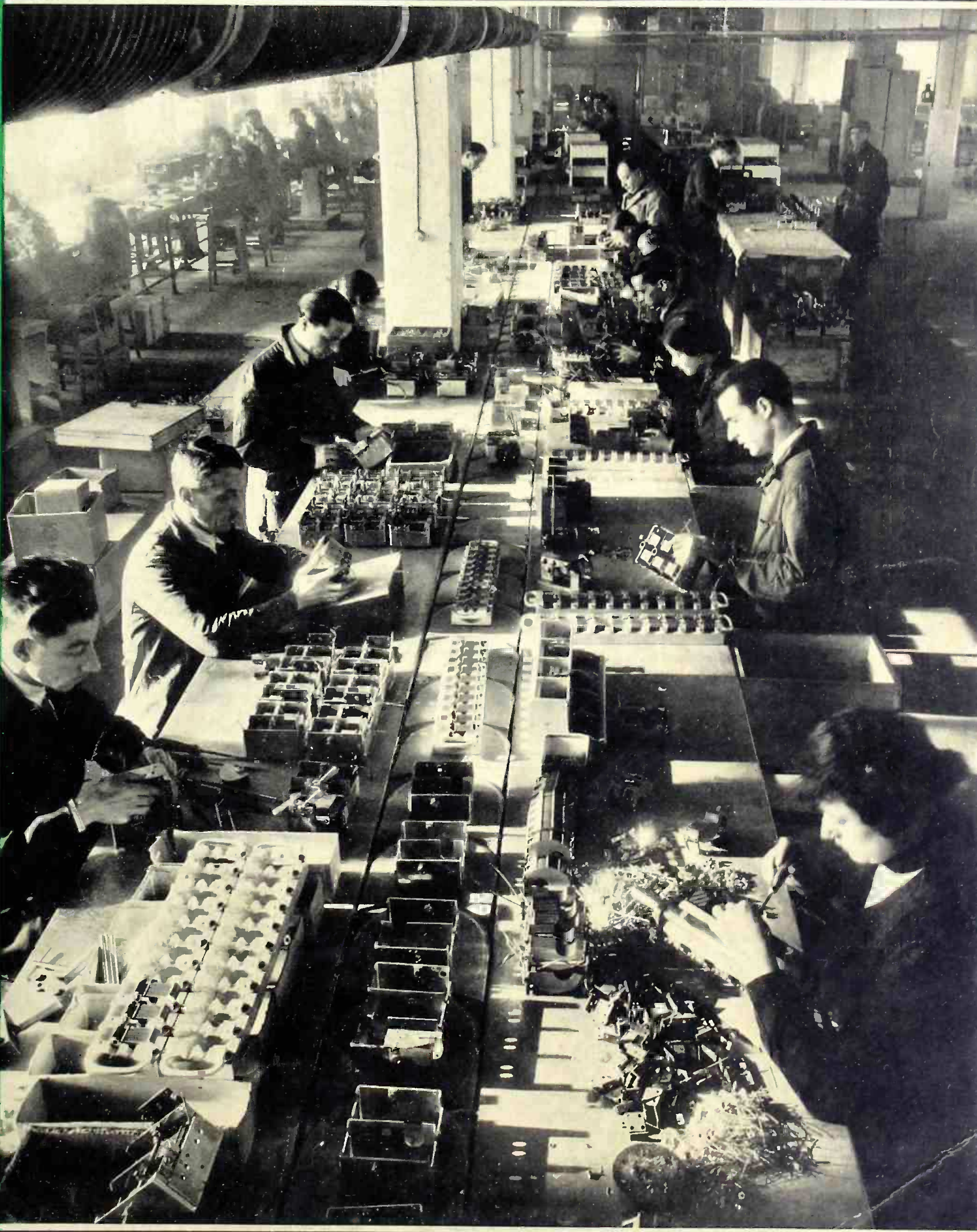

Photo shows Italian radio plant using American methods

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APRIL, 1933

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FOR more than 30 years, the Hygrade Sylvania Corporation, and its predecessors have supplied the electric light industry with standard lamps of highest quality and uniformity. And since earliest days of radio, this company has pioneered in the development of radio tubes.

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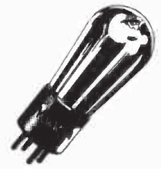

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Electronics, April, 1933. Vol. 6. No. 4. Published monthly. McGraw-Hill Publishing Company, Inc., 330 West 42d Street, New York, N. Y. $3.00 per year, 35 cents a copy. Foreign Postage, $4 U. S. Currency or 20 shillings. Canada (including Canadian duty), $3.50. Entered as second-class matter April 4, 1930, at the Post Office at New York, N. Y., under the Act of March 3, 1879.

O. H. CALDWELL
Editor
KEITH HENNEY
Associate Editor

electronics

McGRAW-HILL PUBLISHING COMPANY, INC.

Vol. 6, No. 4. New York, April, 1933

radio
sound pictures
telephony
broadcasting
telegraphy
counting
grading
carrier systems
beam transmission
photo cells
facsimile
electric recording
amplifiers
phonographs
measurements
receivers
therapeutics
traffic control
musical instruments
machine control
television
metering
analysis
aviation
metallurgy
beacons
compasses
automatic processing
crime detection
geophysics

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A Month of Electronic Events

President Roosevelt, in the midst of the banking emergency, changes the whole public psychology by a 13-minute talk over the nationwide radio networks.

A great Atlantic liner talks with a ship below the horizon, by means of a modulated light-beam playing on a distant cloud-bank.

New realism in sound reproduction—three-dimensional "talkies" or telephony—is made possible by binaural or stereoscopic pickup.

An infra-red "fog-eye" locates hot ships' funnels through a naval smokescreen,—in preparation for iceberg detection through fog later this Spring.

To eliminate troublesome fading, KDKA engineers obtain baby blimp to hold antenna aloft to a vertical height of 1500 ft.

Professor Theremin, musical-instrument inventor, now applies "space control" principle to industrial uses, machinery operation, police alarms.

Sodium-vapor lamp installations, with luminous efficiency sixfold that of tungsten, are put in operation in England, Holland, Belgium, Denmark.

Engineers experiment with 8- and 9-prong tubes; on combined detector-output tubes; on two-tube superheterodynes.

A plane takes off in fog in Washington, never sees ground until guided to earth by short-wave landing beam at Newark Airport.

Bergen County Police Hackensack, N. J., install police radio system on 2480 kc., get reports on reception all over state and N. Y.

Leading radio manufacturer produces a four-tube radio receiver, to retail complete with tubes and dynamic speaker, at $12.95. Factory price, $6.40.

WE pick the above at random from the crowded record of electronic happenings in a span of thirty days. These examples show how varied, how potent, and how far-reaching are the changes which the electronic tube is injecting into the world around us.

THE TIME TO RE-STYLE

New outlines, new materials, new arrangements, new conveniences, new colors

As SPRING days roll around, hundreds of shining, new-styled automobiles are appearing on the American scene. Each such car with its striking new lines so "different" from preceding years' patterns, is exerting throughout its whole town or neighborhood, a subtle and insidious influence to make all earlier models obsolete! As each new car appears in town, watch how restlessness is instilled in even the most conservative households; how in homes where budgets are balanced by the slenderest margins, dinner-table conversation has now veered to the possibility of "turning in the old bus" and getting one of the beautiful new cars.

And there you have an example of the work of the industrial designer. The automobile industry is only one of the fields where styling and new artistic models have been put to work as a powerful lever to move merchandise.

How long before radio manufacturers will apply similar striking new models and radical new designs to make all preceding radio sets obsolete?

So far, the radio industry has made its chief bids for sales with new circuits and tube developments. With technical-sounding big words in the ads, these claims have appeared impressive in print. But all the novelty has been intangible and inside the case, where only a radio engineer could detect it. The new sets have sounded little different, and they have looked little different from year to year. The makers of radio sets have been going on from year to year making models that looked like preceding models. And incidentally they seem to have been models that make little direct appeal to women from the standpoint of external appearance. Radio manufacturers have not yet fully utilized the principle that women do 75 to 90 per cent of all spending and buying for the home. And that therefore "eye value" now becomes of increasing importance if a radio set is to be so designed that the woman of the household will set her heart on having it as a welcome addition to her home interior—instead of considering the radio set as an extraneous, mildly-objectionable object to be suffered, in order that the rest of the family may enjoy the wonderful broadcasts the radio set brings.

Probably no other object or article to which styling and modern industrial re-design can be applied, offers such possibilities for radical new outlines, new forms, and new materials, as does a radio set. It is not limited in shape or substance as is an automobile or a clock. Its control elements and operating mechanism may be disposed at will, for the convenience of the user and the taste of the designer. Externally it may employ a wide range of materials, metals, compounds, compositions, fabrics, lacquers, colors,—as listed on these pages.

Wide influence of Chicago World's Fair

Another factor coming into the design picture this year, is the Chicago "Century of Progress" Exposition, which will open in June. The architectural conception and execution of this whole group of exposition buildings, is of the most modernistic design. Not only will these buildings and exhibits be pictured in every newspaper and magazine throughout six months of 1933, but millions of American citizens in towns large and small, will get out the family automobile and motor to Chicago to see the Exposition for themselves. Indeed it is figured that with 1933 conveyances, the average American home is only about one-tenth as far away from Chicago as it was from the Chicago World's Fair of 1893.

The Chicago exposition this year may be expected therefore to have a tremendous effect on the tastes of people throughout America, even in the small towns and in rural districts. The modernistic outlines of the exposition will definitely affect designs of radios, clocks, plumbing, and many other things. The many thousands

What Re-designing and Re-styling Have Done for Sales in Other Fields

The re-designed Big Ben alarm clock started up Western Clock Company's factories and kept them going during 1932 depression year

New modernistic gas ranges have increased gas-range sales 25 per cent

Macy's drug department, New York, redesigned packages, increased sales 200 per cent

New artistic platform scale of Toledo Scale Company, in 1932 broke ten-years' sales records

Tycos Stormoguide, redesigned along modern lines in 1931, doubled its 1929 boom sales

New Eastman camera, with improved design, has proven camera sensation of Europe and America, despite depression year

Every recent major success in automobile industry can be traced to a new-design idea

Novel attractive preserve jar, justified doubled price, and tripled sales volume.

The new Corona typewriter, introducing improved lines and color, speeded sales

China and glassware, re-designed, have increased pre-depression sales activity

The acousticon, deaf aid, re-designed, immediately doubled sales

AMONG OTHER PRODUCTS now undergoing re-styling are bottles, tools, hardware, office furniture, watches, suspenders, ice-boxes, pencils, sky-scrapers, busses, street-cars, lamps, electrical appliances, safety-razors, gasoline-pumps, radiators, plumbing fixtures.

RADIO SETS IS NOW!

Cabinet designer's job is to give sets new merchandising appeal for 1933 sales

Re-styled, this table barometer has sold twice as fast during depression years, as the old model sold during the 1929 boom

of people who attend, and the many millions who look at the pictures in magazines and rotogravures, are bound to be influenced. It may be expected that an entirely new trend in design of radios and other articles, will become acceptable to the public as it has never been before.

Radio Style Clinic at New York

Such re-styling of radio sets is a matter to be carried out by each radio manufacturer in his own way, in collaboration with designers of his own selection. It would seem desirable to have the radio industry itself hold conferences for the interchange of design ideas, working with the best industrial designers of the country, so that a common direction might be given to the new styling trend, which would make its acceptance easier in the case of individual manufacturers' models.

The first move in this direction was a Radio Style Clinic held at New York City, March 20, under the auspices of the National Alliance of Art and Industry, an organization supported by Rockefeller and Carnegie endowments and individual memberships, and having as its purpose the bringing together of executives in various fields with competent designers and industrial artists. Similar clinics have been held for a number of other industries, and the style influences growing out of these contacts have exerted marked improvements in design and merchandising results in those fields.

This March 20 Radio Style Clinic was attended by a number of radio manufacturers, and by such leading American industrial designers as Henry Dreyfuss, Walter D. Teague, Margaret Dargan, Christoph Castou, Ruth Gerth, Hugo Gnam, Ray Greenleaf, Vahan Hagopian, Gilbert Rohde, Lee Simonson, Marion Taylor, John Vassos, David Wald, J. M. Streng, George E. Ball, L. Walsh and others.

The purpose of the Clinic was to obtain free discussion of the problem of increasing radio-receiver sales through improved external design and artistic appearance. The meeting broke all records for similar clinics, lasting from the luncheon hour of 12:30 until 4:30 p.m. during which time a wide variety of opinions was discussed, and the manufacturers present got from the designers and from merchandisers, some very frank statements and comments regarding present radio models. In this way the radio men in attendance had an opportunity to contact the design people, and to become acquainted with individuals.

Of course, no recommended designs for radio receivers were exhibited, perhaps to the disappointment of some of the radio men present. Obviously, leading designers who are busy with designing in other fields, would not be willing to throw before a public meeting their best ideas for radio-set designs, and of course they would not want to be represented by any designs not their best. The matter of bringing out such designs therefore would seem to be a subject to be handled by individual manufacturers in connection with their own re-styling plans.

The National Alliance of Art and Industry, which has headquarters at the Art Center, 65 East 56th St., New York City., has no designs for radio sets to offer to manufacturers. It is a disinterested clearing house for information regarding designers, design trends, etc., and offers its services to advise radio manufacturers in finding the types of designers they desire. Mr. Alon Bement, director, has invited individual manufacturers to consult with the Alliance in attacking their design problems, and in getting into touch with competent and experienced designers. In the event that a group of radio manufacturers desire to discuss general future trends in radio-cabinet design, it would appear that the Art Alliance, with its facilities, could offer valuable disinterested general guidance.

New materials for re-styling

Products which have been employed in re-designing many other lines

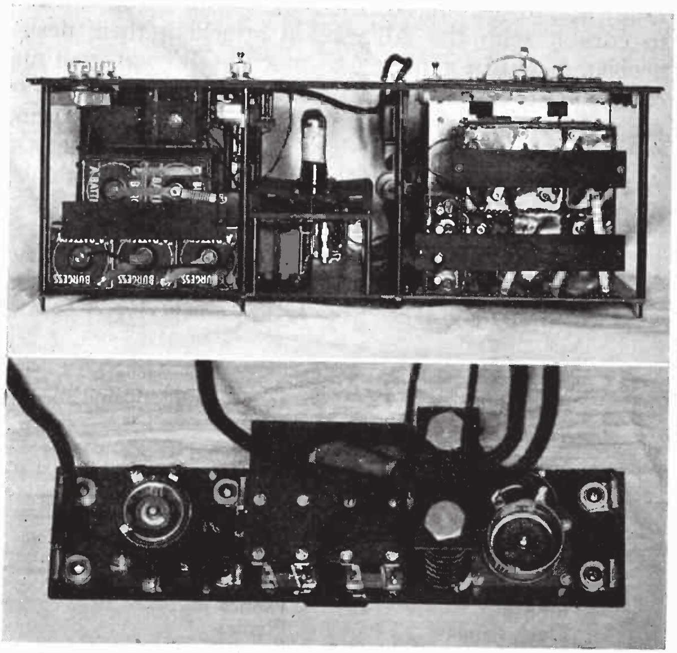
Chromium plate
Aluminum
Aluminum colors
Zinc
Zinc alloys
Copper
Brass
Bronze
Steel, stainless
Steel, laminated
Nickel
Lead alloys
Tungsten alloys
Silver trimmings
Hard woods
Inoculated woods
Colored woods
Cellulose compounds
Acoustic products
Leather
Synthetic leather
Fabricoid
Fabrics
Plastics
Bakelite
Durez
Plaskon
Lumbreth
Glass
Lacquers, paints

Aids in manufacturing Electronic apparatus

A RADIO set may appeal for a variety of reasons; it may have convenient controls, extreme sensitivity, excellent fidelity, automatic volume control, compensated audio amplifier, two loudspeakers, and remote control. However, a radio set which is expensive to manufacture will seldom compete seriously, in a quantity market, with a set which is not quite so desirable, but very economical to manufacture. If, in addition, the repairs and replacements needed to maintain the less expensive set over a reasonable period can be effected with a minimum of trouble and expense, the product will have the major features of a success.

There is a close comparison between the electronic apparatus used in industry and the familiar radio set. For industrial apparatus the emphasis should include reliability, and simplicity of maintenance. The three main features may be termed: (1) Utility; (2) Desirable Manufacturing Details, and (3) Simplicity of Repair and Service.

It will be assumed that the engineering work has been done, and that a satisfactory working model has been constructed. This will mean that all leads are properly grouped, shields in place, controls conveniently mounted, and tubes easy to insert. Even after the completion of a working model, there are many problems awaiting the manufacturer. By properly choosing the most desirable of several courses of action, the parts and assembly can be made with a minimum of time, at a reduced labor cost, and with few rejections.



Electro-cardiagraph with cover removed (Westinghouse). An interesting assembly between two panels. Below—the control assembly of an oscillograph

Referring again to the radio set, there are some items which are subjected to mechanical wear; the loudspeaker coil and cone, the volume control, rheostats and potentiometers, tube socket springs, switches, and plugs. These should be chosen, or designed, for ruggedness and ability to stand severe abuse, especially in shipping and handling. The assembly, when packed, should be strong enough to withstand a drop of several feet—as this may be a part of the "baggage smasher's" routine. Intelligent packing is essential, but rugged internal construction is a primary requisite. Before production, an engineer familiar with mechanical principles should go over the model, and provide sufficient bracing, and reinforcing for such parts as may require it.

TOLERANCES Tolerances are an important consideration in assembly and circuit work. By keeping all dimensions within a few thousandths of an inch, absolute interchangeability is assured, but the cost may be greatly increased, due to the shrinkage in passing inspection. For example, if holes are to be drilled, and there is no urgent need for extreme accuracy, a large allowable variation should be specified. Tolerances also apply to materials; the thickness of the material for transformer and condenser cans may be plus or minus several thousandths (depending on how the die is made) without in any way detracting from the proper functioning of the can as a shield and support.

Similarly, the chokes and condensers used in a "brute force" filter do not have to meet very exacting limits, and the proper tests will allow the use of units which are somewhat different in electrical characteristics. The condensers and coils used in a gang-tuned circuit, however, must be held to close limits, to allow the desired "tracking" of the multiple-tuned circuits.

FINISHES The use of expensive finishes for apparatus or parts which are out of sight is seldom justified. A simple rustproofing is usually all that is needed. The advent of cheap cadmium plating has greatly simplified the finishing of steel parts. Sprayed lacquers also are used for this purpose. Spraying can be done on certain partial assemblies where plating is not possible. Some metals, such as aluminum, when used in variable condenser plates, do not require finishing.

Electronic apparatus is likely to become popular in a variety of foreign countries, which may have a different climate from our own. It will therefore be advisable to supply finishes which are permanent under severe extremes of heat, cold, and humidity.

TOOLS AND DIES FOR METAL WORK The manufacture of the small parts which are later to be assembled in the finished product should be given careful attention. If a large quantity is to be made, expensive tools are entirely justified, as the individual cost can thus be greatly reduced. For example, a draw die for making a transformer may cost several hundred dollars, and if ten thousand pieces are to be made, the tool cost per unit will be very low. If this particular can were to be made by hand, the unit cost might be as much as a dollar. Yet if only one hundred were to be made, the total cost would be only one hundred dollars; not enough to justify the cost of the die.

It may be said that dies are justified when they can liquidate their investment in less than a year, meaning that the expectation is for a reasonably large immediate production of that particular item. The carrying of tool costs over a period of several years is a risk, as changes or improvements may make the tools obsolete. An apt illustration can be drawn from the automotive industry; the expensive body dies are designed to make a single line of car bodies, and are usually obsolete within a year, when a new model is brought out.

DIES FOR MOLDED PARTS Dies for molded parts may not be as expensive as dies for metal work. This means that the use of molded parts does not require the large production which is required for the economical use of metal-working dies. A further advantage of molded parts is the possibility of including fairly intricate parts in the mold, improving the ease of assembly, and reducing the number of parts required. Molded parts, in general, are used for pieces in which the insulation is a feature. Parts having excellent electrical characteristics and resistance to moisture can be made cheaply. Interesting money-saving details can often be included; for example, if several similar pieces are to be made from the same die, the holes may all be spotted, and only those peculiar to the apparatus being made will be drilled. If the minimum die and production cost is desired, it is better to use as few mold parts as possible, and to avoid inserts and threaded parts. Added strength is easily added, thin sections can be reinforced by ribs, and corners provided with fillets.

SCREW MACHINE PARTS The set-up cost for an automatic screw machine is not very high, this making it economical for making small round parts in either small or large quantities. Careful design will frequently enable such parts to be made in one multiple operation, a turret head bringing several tools to the work in performing the desired cutting and threading operations. The use of high-speed steel or similar durable tools will enable the manufacture of many pieces without tool grinding. In large quantities, a disk-like tool having the required contour is easily sharpened by simple straight-line grinding. Free-cutting metal which is homogeneous will insure the maximum output from automatic machines.

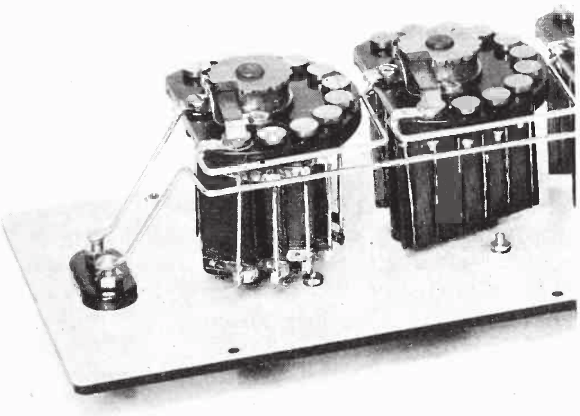
Testing jigs, or gages, are used periodically to insure the uniformity of the pieces. Here, again, the tolerances should be definitely known, and inspection gages provided for the limits of the allowable variation.

CASTINGS Fairly complicated metal parts can be made cheaply in small quantities by the use of castings. Wooden or metal patterns are suitable for the ordinary sand castings, and the truing up of the cast piece in making a presentable product can frequently be done more cheaply than the assembly and finishing of a similar item fabricated from component metal parts.

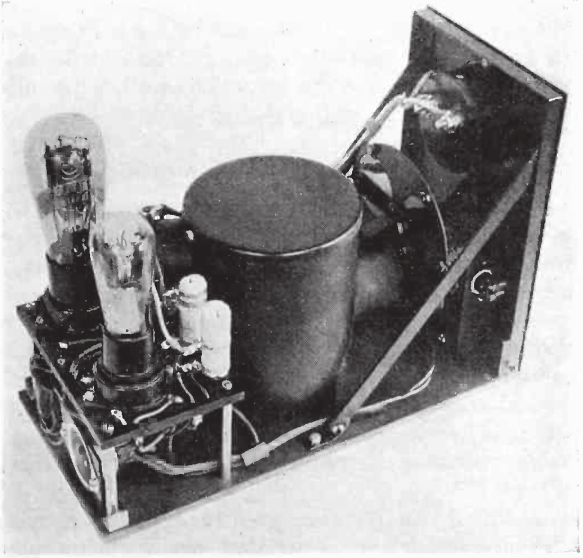
Die castings require more elaborate dies and casting procedure, but present an excellent finished appearance with a minimum of work after casting. Die castings can be made accurately to close tolerances, and for small parts they are especially desirable.

MACHINE TOOL OPERATIONS The use of a milling machine, or planer, usually entails a high set-up cost. To reduce this, jigs can be provided for quickly positioning and clamping the work. (An excellent book, Time and Motion Study by Mogensen, McGraw-Hill Book Company, shows how to ana-

New 8-prong socket for radio tubes under development. The socket is a good example of the use of laminated fiber



Single panel mounting is shown to advantage in this cut of the General Radio resistance box. Note the soldering of terminal connections



A good example of sturdy construction, of the use of bracing and accessibility for wiring. (Westinghouse color matcher)

Typical production line in a radio set factory. (Courtesy of Parker Kalon.) The cover of this issue of *Electronics* was taken in an Italian radio factory, demonstrating the use abroad of American methods of mass production

lyze and improve processes. The following numbers refer to pages in this book.) A kit of all the tools needed for a particular job will also speed up work, by eliminating trips to the tool room, thus avoiding the needless expense of idle machine time.[84]

A drill press is one of the simpler machine tools, and a simple positioning jig will allow its economical use. Multiple drills are justified when large numbers of similar operations are to be performed.

ASSEMBLING APPARATUS The use of "straight-line production" is frequently advocated as an excellent method of assembling a product.[172] This may be taken to mean a moving conveyor from which operators take a partly finished chassis, add their particular item or perform their operation, and then return it to the conveyor. In many cases this general method is excellent, and capable of increasing the speed and facility of assembly. Unless used with an intelligent knowledge of its limitations, however, the use of a long straight conveyor may not be especially desirable. For certain operations the worker may use more time in the removal of the part, and the return, as well as the added effort in these transportations, than is desirable.

Savings by proper process grouping

The main advantage to be gained by the use of a conveyor is a decrease in the transportation of a partial assembly from one operation to the next. This can often be done without a conveyor by strategically grouping consecutive operations, so that upon the completion of one operation the next operator may conveniently obtain the partial assembly.

An ideal arrangement is to have the parts in containers in a circular work place before the operator, so that no extensive reaching is required to collect the desired parts.[46, 63, 100]

Tools already in position greatly expedite assembly. A ratchet screwdriver suspended on a spring within easy reach of the operator eliminates searching and reaching.[77] The release of this tool after use returns it to its former convenient position.

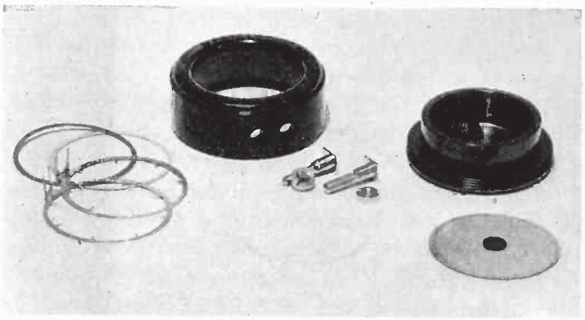
Clamp jigs for eliminating the use of the hand as a "vise" decrease fatigue and increase production, especially when both hands can be usefully employed.[82] Frequently two similar assemblies can be made simultaneously, one with each hand, thus providing symmetry of motion and body balance. The release and "hold" features of the assembly jig can be foot operated.

In making the "delivery" after completion as simple as possible, time and effort is saved. A drop delivery is one in which the operator releases the item from the assembly jig, the piece falling into a chute; which can be of canvas for fragile parts,[36] the pieces being transported for further operations, or collected for temporary storage.

STORAGE AND INSPECTION Temporary storage of partial assemblies may be needed when such items are parts of similar outfits, and set-up time is saved by making up a large quantity at one time.

Inspection of partial assemblies, especially of parts which may be subject to shrinkage, is very desirable. Parts such as resistors, switches, transformers, coils, etc., should be checked for electrical characteristics, both before and after assembly.

REPAIR AND SERVICE DETAILS Some details which improve the ease of servicing, also apply directly to the assembly and design features. Much of the ease of such repair work can be built into the apparatus by careful planning and simplifies the assembly.



Moulded case of Weston Photronic cell. Moulded material enters widely into modern construction

An important feature is the accessibility of each individual item for replacement or repair. This is most easily accomplished when a single mounting base is provided, and no units placed in such a way as to cover other units. As examples, the power transformer and condenser block should be easily removable. The use of rivets is fairly simple in assembly, but the use of self-tapping screws is also a good assembly arrangement, and greatly helps the serviceman. The use of lock washers and screws is desirable for parts where vibration is encountered, such as in loudspeakers, yet the dissembly feature is retained.

Potentiometers and variable resistors can be obtained for single-hole mounting, concentric with the operating shaft, and are easy to remove, and reassemble.

The use of tinned and numbered terminals on transformers and condenser blocks makes for easier wiring and soldering in the original assembly, and they are very convenient for replacement purposes. Color coded cables are a great help in tracing connections.

Complete "picture diagrams" showing the exact location and color of leads, with the numbered terminals of the component parts allow an average serviceman to render expert and speedy service.

NEW TUBES + +

NEW TUBE MATERIALS

MARCH, like all recent months has been an active period for tube manufacturers. Engineers in both tube and set laboratories are elated at having discovered an old law, that of permutations. Given X elements in a tube, the total number of combinations of these elements into different kinds of tubes is X to the *N*th power, or something like that. These engineers need not feel so happy; the law is old, it might even pay them to look it up. Carried far enough it becomes another old law, that of diminishing returns.

New rectifiers of all types, gaseous and high vacuum, heater and filament-type cathodes, single wave, double wave, double wave with center tap, 6.3-volt heaters, 12.6-volt heaters, the same with center tap, and finally 25-volt heaters—all have been announced recently. The characteristics of some of these tubes will be found below. Several new amplifier hybrids have come out since February *Electronics* when the most recent additions to the tube family were described. These include a 2.5-volt tube of the 75 type, detector-pentodes and a variable-mu r-f pentode.

The limit in complexity of tube types does not seem to have been approached as yet. Conversation with various tube engineers, following the introduction of combination detector-oscillator hybrids, brought forth the article in this issue by Mr. Nelson. This represents experimental work on combined detector-output tubes carried out some time ago and pigeonholed. Present trends are toward smaller and cheaper sets (witness RCA Victor getting into the $6.40 to jobber class for a 4-tube set) engineers are aiming at further and further consolidation of tube functions in one bottle. The detector-power output tube would make possible a three-tube super including rectifier. As evidence that work is going along more complex lines, note the 8-pronged socket on page 91 of this issue.

So much for new tubes. In the meantime the manufacturing departments of the tube plants have not been idle in searching for new materials, new processes, and new methods of reducing costs. As reported in February *Electronics* much work is being done with substitutes for nickel for plate material. For power tubes, carbon plates (National Carbon Company) are being used by at least one company. The ability to dissipate considerable heat and somewhat lower cost than molybdenum indicate that although still in the experimental stage, the use of carbon may come into rather wide acceptance.

For the smaller tubes, i.e. those for use in radio receivers, the new material is "Svea" metal, manufactured by the Swedish Iron and Steel Company. This is a specially prepared grade of iron which by reduction of impurities, elimination of gas, and other special treatment, offers the tube trade a new metal for plates, getter cups and other parts now made solely of nickel. (See *Electronics*, December, 1932, page 379.)

Although manufacturers are showing characteristic caution in not swinging over whole heartedly to the new materials, all of them are experimenting with Svea metal and a number are already in production with it. The first advantage is that of cost, there being an immediate difference in cost, over nickel, in sheet form amounting to as much as 40 per cent on the weight basis and because of lower density there is some further advantage In the form of wire and woven mesh the differential is much less.

NEW RECTIFIER TUBES

		Cathode					
Type	Description	Type	Voltage	Current	R.M.S. Volts per Plate	Max. peak inverse Voltage	Average Output M. A.
6Z-3	Half wave	Heater	6.3	0.3	350	1,500	50
6Z-4	Full wave	Heater	6.3	0.3	...	....	..
6Z-5	Full wave	Heater	12.6	...	...	....	..
12Z-3	Half wave	Heater	12.6	0.3	230	....	60
25Z-3	Half wave	Heater	25.0	...	...	....	..

Reports indicate that the iron can be handled about as easily as nickel but that it has a tendency to oxidize, that it may be somewhat easier on forming and stamping dies but probably somewhat more liable to distortion and warpage on subsequent heating. On exhaust, iron heats up more quickly to a certain critical temperature and then more current in the heating coil is required to boost the temperature to the final value. This may call for some changes in exhaust schedules.

If marked economies in manufacture can be secured, iron, or other metal or material, will undoubtedly be used widely, always provided there is no decrease in life or change in characteristics after the tube is in service. For cathodes and filaments it seems totally unsuited. Other parts of the tube will probably not be adaptable to other materials than nickel due to manufacturing and processing difficulties.

NEW AMPLIFIERS AND DETECTORS

		Cathode			Plate			Voltage			
Type	Description	Type	Volts	Amps.	Volts	Amp.	Res.	Grid	Screen	gn	μ
6C6	Det-Pentode	Heater	6.3	0.3	250	.003	1.5 meg.	—3	100	1225	1500
6D6	Var. Mu-Pentode	Heater	6.3	0.3	250	.082	0.8 meg.	—3	100	1600	1280
2A6	Same as 75 except for 2.5 volt heater.										

Considerations on detector-output tube systems

By J. R. NELSON
Raytheon Production Corporation

RECENT publicity to the possibility of 2-tube superheterodyne[1] receivers involving one of the recently announced oscillator detector tubes and a possible detector-output tube makes it desirable to consider such a tube. This article is devoted to a discussion of some of the possible types of combination tubes for this latter service. It is assumed that a tube of this type would be of use chiefly in small sets where low cost and economy of space are important features. In general it is not to be expected that a combination tube can give results equal to those that could be obtained from separate tubes involving similar elements and the larger cathode areas that could be used in separate tubes. This discussion is theoretical to the extent that it refers chiefly to tubes that are hypothetical and the advisability of whose production is at present, questionable.

Necessity of a new tube

First consider the equivalent circuit of a conventional tube with two internal generators of different frequencies, an internal resistance, and an external resistance. The total current that may be used by the device without distortion will be limited to the steady current of the tube and the voltage that may be built up externally is limited to something less than the B voltage; otherwise considerable distortion will occur. It is thus seen that if we have the two voltages acting in the tube, and one, V_1 is considerably greater than the other V_2, the power which V_2 can deliver to the external load will be small because we cannot eliminate the effect of the V_1. If we use a choke to cut down the current caused by V_1, the effective voltage is reduced, while if we bypass the external load, the current caused by V_1 will be large inside the device thus limiting the current which we can obtain from V_1. If we assume that V_1 (the larger) is the carrier and V_2 (the smaller) is the audio modulation frequency, we may arrive at some estimate of the undistorted power output obtainable with any percentage of modulation. Assume that M is 33 per cent so that V_2 is one-third of V_1. Thus V_1 may be only one-quarter of the value we could use if V_2 were zero. Thus if the power is proportional to the square of the input voltage, the reduction is one-sixteenth. Actually, however we can run up the input voltage above this value so that the reduction will be something less than this.

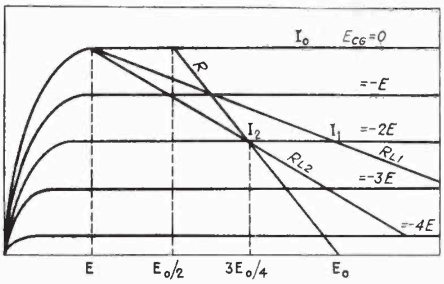


Fig. 1—Plate characteristics, hypothetical duplex control-grid pentode

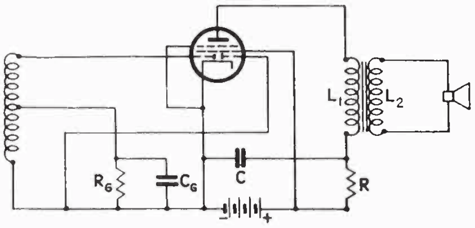


Fig. 2—Circuit diagram for duplex-grid pentode

Four methods of getting around the fundamental limitations in the conventional type of tube suggest themselves. These methods involve ideas already applied to detector and combination detector-amplifier tubes.

1. Twin control-grid pentode amplifier.
2. Combination diode and pentode amplifier.
3. Combination triode and pentode amplifier.
4. Combination diode, triode and pentode amplifier.

Method 1 will be considered first. Assume that the plate characteristics of a pentode having two control grids are given by Fig. 1 when the two grids are tied together. The circuit in which such a tube might be used is given in Fig. 2. The two grids are symmetrical so that the effect of the high frequency is balanced out in the plate circuit. The rectified voltage across R_g and C_g is, however, applied in phase to the two grids so they act as one grid. The reasons for the circuit elements R and C will be explained below.

Twin control-grid pentode

The plate current curve for no signal is represented by the curve for zero bias. If the inductance L_1 has very low resistance and if R is zero the operating point will be I_0 at the voltage E_0 where it is assumed that E_0 is the maximum rated plate voltage. The operating point of the tube is supposedly I_1 at E_0. The power dissipated in the tube will then be approximately twice that for which the tube is designed and the tube would be overloaded. If the resistance R is used so that it intersects the curve for zero bias at $E_0/2$, the d-c wattage in the tube will then be approximately the rated value with no signal.

If a signal is applied which gives a bias of $2E$, the operating point is I_2. The load resistance R_{L2} should be such so that it would intersect the zero curve at E. The power may then be easily found. If a bias $-2E$ could be applied so that R could be made zero, the load resistance could be R_{L1}. As the same current is assumed in each case, that is, R_{L1} and R_{L2}, both intersect the zero bias curve at the same point, the power will be proportional to the two load resistances. It is thus seen that some reduction of power must occur because it is necessary to use a resistance R as shown in Fig. 2 to limit the power taken by the tube with no signal and hence no bias on the grid. The resistance R although bypassed will obviously reduce the power because it reduces the effective plate voltage.

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[1]See *Electronics*, Page 64, March 1933.

Theoretically the r-f input voltage swing should not be more than the bias voltage of the tube as an amplifier. For example, consider Fig. 3 where it is assumed that the operating voltage is $-2E$. If enough r-f voltage is used to bring the operating point to $-2E$, the r-f current is cut off in the negative swings while it reaches the value of I_0 on the peak positive swings. If the value of the r-f is increased, the current can decrease no further on the negative swings while it can still increase on the positive swings which would thus cause the average plate current to increase. If we stop at the theoretical limit the power is reduced on the lower percentage of modulation by the ratio of $(M/100)^2$ as we can only realize the full power output with M equal to 100 per cent. In practice we can, however, stand considerable unbalance of plate current so that we can run the power up considerably over the ratio given above.

Experimental results

An experimental tube was made up with two grids to see how much improvement of performance over a regular pentode could be obtained. The improvement was checked by connecting the grids out of phase and then in phase, thus using the same tube in each case. The tube made had rather poor G_m, but the results serve to indicate the improvement that may be obtained against per cent modulation.

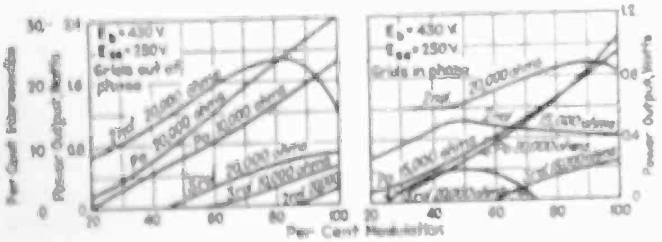

Fig. 3—Power output and distortion of duplex control-grid pentode

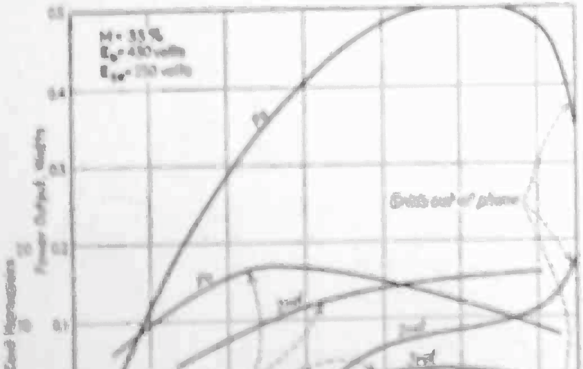

Fig. 4—Output characteristics of duplex control-grid pentode

A circuit similar to Fig. 2 was set up. A carrier frequency of 1,000 kc. which could be modulated any desired percenatge was used to supply the input. The results obtained for various modulation percentages using two plate load resistors are shown plotted in Fig. 3. The grids were out of phase in Fig. 3a and in phase in Fig. 3b. In each case about 20,000 ohms was the optimum value of load resistance. It can readily be seen that considerable improvement both as regards maximum output and distortion result when the grids are connected out of phase. The power output was about 2.5 times as much when the grids were in phase. As a matter of interest the power output with an a-f voltage only on the grids was 3.1 watts so that the efficiency for 100 per cent modulation was about 75 per cent.

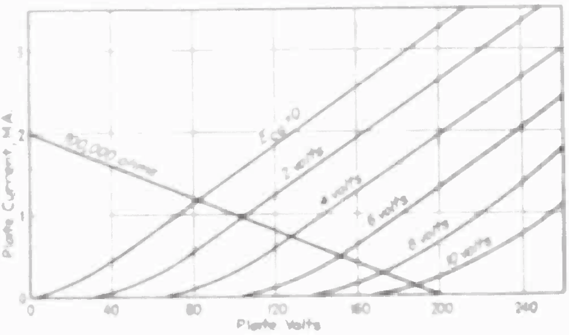

Fig. 5—Plate characteristics of triode section suitable for insertion in pentode structure

Figure 4 shows the results obtained when the modulation was kept constant at 33 per cent and the carrier voltage was varied. Figure 4 shows that considerable improvement is obtained when the grids are connected out of phase over the condition when the grids are connected in phase as shown there. The maximum power with the grids out of phase is about 0.5 of a watt compared with 2.5 watts for 100 per cent modulation. It is thus seen that the maximum power for 33 per cent modulation is about one-fifth that for 100 per cent modulation instead of one-ninth as previously calculated.

Other possibilities

Method 2 is by far the simplest. The pentode section may be biased to its optimum value so that R and C shown in Fig. 2 will not be necessary. The sensitivity will be about the same as that of the twin control-grid pentode tube. The performance to be expected with this tube will follow closely that of a separate diode and pentode so that no discussion will be given for this case.

Method 3 is simple enough in theory as the triode would be used as a detector feeding into the pentode output stage. Figure 5 shows the characteristics of a triode suitable for insertion in the pentode structure. The plate resistance is rather high so that it would not be practical to use iron-cored reactors as transformers in the plate thus making resistance coupling the only practical method of coupling to the pentode input. The gain which can be realized as an audio amplifier is considerable as shown by the 100,000-ohm load line drawn in from 200 volts. However, it would not be practical to work such a tube as a grid circuit detector in this particular application. For example, if we impress a three-volt signal modulated 33 per cent we would have

[Please turn to page 98]

The single-tube thyratron inverter

By O. W. LIVINGSTON
and H. W. LORD
General Electric Company.
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THE single-tube Thyratron inverter in its numerous modifications is so often useful as an electronic tool that a brief consideration of its fundamental operation and a few examples of its operation will be helpful to anyone concerned with electronic devices.

There are two general arrangements of the single-tube inverter, each subject to many variations. Figure 1 shows the first to be considered. Assume switch S_1 to be closed on a direct current source. Since the condenser is discharged, the potential of the cathode d is at the same potential as b and the grid is positive by the voltage b–c. If the critical grid voltage of the tube at this anode potential is less positive than this amount, the tube starts to conduct. The current passes from the positive line through the inductance L, the resistance R_1, the Thyratron T and the condenser C shunted by the resistance R_2, back to the negative line. If R_2 is sufficiently high and R_1 sufficiently low the current will build up rapidly and the voltage across the condenser C will soon equal the line voltage. The current does not cease at this instant, however, due to the inductance L. A certain amount of energy is stored up in the inductance and as the current diminishes, the collapsing flux induces an e.m.f. which causes the current to charge the condenser to a voltage greater than that of the line. If R_1 were zero and R_2 infinity, there would be very little damping of the circuit and the voltage of the condenser C would approach twice line voltage less tube drop when the current finally falls to zero. As a consequence of this overcharging of the condenser, after the current has ceased to flow the cathode d of the tube is more positive than the anode, or the anode is negative with respect to the cathode. Since current cannot pass from the cathode to the anode of the tube, due to its rectifying property, this condition exists until the condenser, discharging through the resistance R_2, has reached line voltage. If the resistance R_2 has been chosen large enough, this allows sufficient time for the tube to deionize so that the grid will be effective. Since the grid is at the potential c and the cathode at condenser potential, the grid is sufficiently negative to prevent the tube from conducting when forward voltage reappears until the condenser has continued its discharge to a point where the cathode and grid are separated in potential by the critical grid voltage. At this point conduction is again initiated and the cycle is repeated indefinitely. This overcharging of the condenser which permits the tube to "commutate" cannot be too strongly emphasized, because it is impossible with the ordinary Thyratron tube for the grid to regain control with ionization in the tube unless excessive grid power is employed.

Figure 2 shows the other fundamental arrangement of the single-tube inverter. In this case, when the switch is closed, the cathode is practically at anode potential since the condenser charge is zero and the grid is negative by the amount of a–c. Therefore, the tube remains nonconducting while the condenser is charged up through the resistance R_2 until the cathode potential of the tube has fallen to such a value that the grid-cathode potential is equal to the critical grid voltage of the tube. Then the tube conducts, the condenser discharging through the inductance L, the resistance R_1 and the tube. In the same manner as described in the first circuit, the condenser is first discharged and then over-discharged, or charged in the reverse potential due to the energy stored in the inductance L. This again throws the anode of the tube negative, affording time for deionization as the condenser is first discharged and then recharged in the original direction through the resistance R_2.

Comparison of two inverters

Figure 3a shows an actual oscillogram of the first type of inverter operating one-third the frequency of the 60-cycle timing wave. The input current through the resistance R_2 is shown, as well as the anode voltage, the latter clearly showing the deionization time available for the Thyratron tube. Figure 3b shows the operation of the second type of inverter under similar conditions. It will be seen that in the first type of inverter the condenser is rapidly charged through the tube and slowly discharged through the resistance R_2 and in the second type the condenser is slowly charged through the resistance R_2 and quickly discharged through the tube.

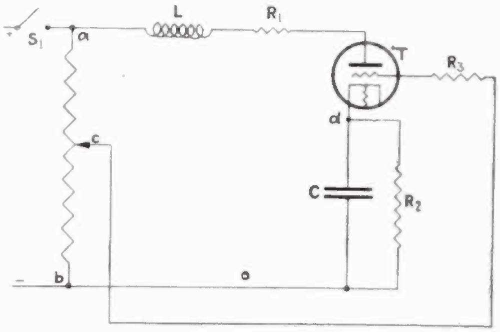

Fig. 1—Fundamental circuit for single-tube inverter

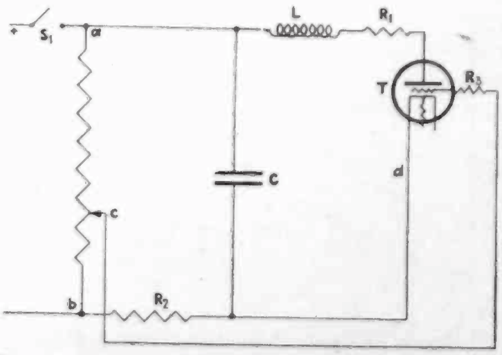

Fig. 2—Variation of fundamental inverter circuit

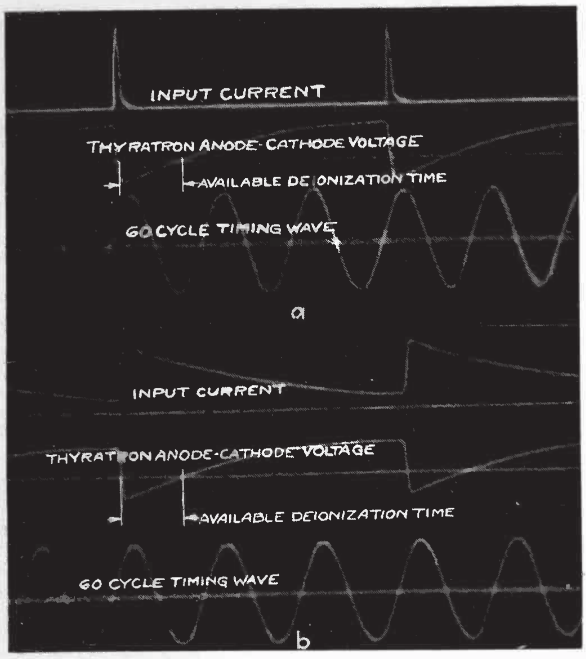

Fig. 3—Oscillograms of inverter. Upper curves are representative of circuit in Fig. 1

Occasionally these circuits are used without the use of the potentiometer, the grid circuit being connected directly to the negative line. This not only removes a convenient frequency control, but also tends to make the timing more susceptible to error. This is due to the low rate of change of the grid-cathode voltage at the time of discharge as indicated in Fig. 4 which shows the lowering of the cathode potential as the condenser in Figure 2 charges up.

Advantage of potentiometer

Assume for the instant that the critical grid voltage is slightly negative. A line x is drawn so that the distance b–x is equal to the critical voltage. Then the tube will start to conduct at the instant the curve crosses the line x. A slight change in characteristic of the tube due to the effect of temperature change, cleanup of an inert gas, or any other cause produces an error shown as ΔT_1. If, however, the grid circuit is returned to point c and the time constant of the RC circuit altered, the tube will trip in the same time T, with a somewhat lower condenser voltage, as shown. A similar change in tube characteristic will then produce a much smaller error ΔT_2 due to the greater rate of change of the condenser voltage, and consequently the grid voltage, at the tripping point.

Still further, the use of the potentiometer compensates for different line voltages. If the anode voltage is doubled, the bias b–c is automatically doubled so that the time is practically constant provided that the critical voltage of the Thyratron tube and the tube drop are both small in value compared to the anode voltage. If these two quantities have a zero value, the time would be absolutely constant with any value of line voltage.

It sometimes happens that it is desirable to have the inverter run in synchronism with a given voltage. If the values of R_2 and C and setting of the potentiometer are set for approximately the right value, a small value of synchronizing voltage introduced in series with the grid circuit will serve to keep the circuit in exact synchronism. By suitable adjustment of the circuit constants submultiple frequencies may also be perfectly synchronized. Multiple frequencies may be held in synchronism although the correction occurs only once per cycle of the synchronizing frequency; and if the circuit constants are not about right, a slight drift may be synchronized.

It will be at once evident that the single-tube inverter is a convenient source for small amounts of a-c power. In general, L and R_1 are replaced by a small transformer the output of which may be stepped up or down to the desired potential. The leakage inductance of the transformer is generally sufficient to overcharge or overdischarge the condenser to insure "commutation." A few of the applications of this nature include the excitation of an a-c bridge circuit at several hundred cycles to improve its efficiency, and the Thyratron tube organ which uses a number of these circuits operating at audio frequencies. If the voltage ratio of the transformer is high enough, we have in effect an induction coil with a tube interrupter which may be used to light neon signs or for other high voltage uses.

If slight modifications are made, such as replacing the resistance R_2 by an emission limited vacuum tube to maintain a constant charging or discharging current for the condenser and the time of the Thyratron tube conduction made very small, a saw-tooth voltage may be obtained across either this tube or across the condenser which provides an ideal linear time axis for cathode ray oscillograph work. The same results may also be obtained by the use of a four-element vacuum tube or by the use of a large inductance in series with R_2.

This saw-toothed wave also is used as the timing element in a recently developed design of electron-tube welder control. By varying a d-c potential in series with the saw-toothed wave, the ratio of the time the resultant voltage is positive to the complete time may be controlled. This voltage impressed on the grids of another pair of tubes controls the ratio of the time current is passed to the time it is off. By changing the

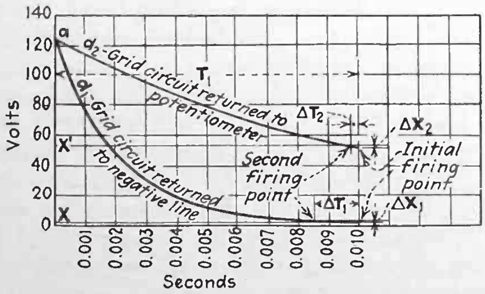

Fig. 4—Errors in firing time when potentiometer is not used

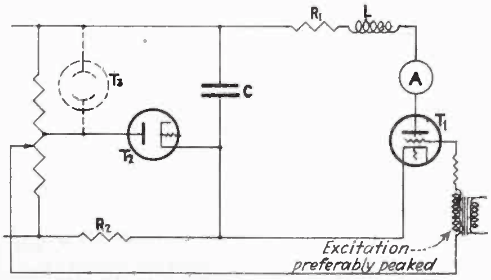

Fig. 5—Frequency meter using electron-tube inverter principle

frequency of the inverter the number of spots per minute of the welder may also be controlled.

Another use of the inverter is for stroboscopic work. If the inductance is made quite small, the time of the tube conduction is so brief that a moving object seen in the light incident to the discharge seems to stand still. Thus, a synchronous motor rotor and shaft seems to stand still if the inverter is synchronized from the same source that is used to run the motor and the rotor of an induction motor seems to move backward proportional to slip frequency. If a shaft to be observed is not running in synchronism with any alternating current source, a small synchronizing voltage may be introduced into the grid circuit by the use of small contacts or by some scheme of inducing a voltage in a small pick-up coil once a revolution.

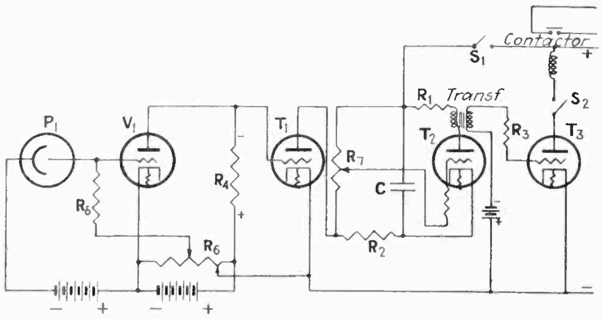

Fig. 6—Flexible time-delay relay using inversion circuit

With a slight modification a calibrated variable frequency stroboscope can be produced which may prove useful as a tachometer in observing the period of repeating phenomena without affecting the phenomena. If the voltage a–c is held constant in either of the fundamental circuits (Fig. 1 and Fig. 2) and the value of R_2 varied, the reading of a d-c ammeter in series with the Thyratron tube anode will be directly proportional to the frequency. Thus, if the frequency of the stroboscope is varied until the highest frequency which gives a single image of the moving part is obtained, a reading of the meter will give the correct frequency. In order to check this reading, doubling the stroboscope frequency should produce two images 180 degrees out of phase.

If this circuit is further modified for external excitation, as shown in Fig. 5, the reading of the d-c ammeter is proportional to the frequency of the excitation. This makes it applicable to a number of frequency or speed measuring problems. The addition of the tube T_2 insures the condensers always charging to the same value at high speeds and a glow tube T_3 affords freedom from line voltage variation errors.

In addition to these and many other applications of the circuits acting as inverters, there is another arrangement which makes use of a non-recurring type of operating cycle.

The circuit shown in Fig. 6, for instance, forms an extremely flexible time delay relay. If the switch S_1 is closed, a definite time later the tube will conduct, making it possible to operate some further device a definite time after the initial movement which closes the switch S_1. By changing the values of R_2 and C, this time may be readily changed from a fraction of a second to 10 minutes or longer.

If the grid lead is returned to the negative line through a small negative bias, the Thyratron tube will never trip unless an additional signal impulse of a positive nature is inserted in series with the grid circuit. This then forms an impulse amplifier in which a weak impulse trips the circuit, giving a powerful impulse whose magnitude and shape is independent of the tripping impulse. This is one scheme of providing a peaked grid excitation for large power Thyratron tubes in multitube circuits where conduction angles are short and the "Firing point" must be accurately determined.

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Considerations on detector-output tube systems

[*Continued from page 95*]

the equivalent of a four-volt swing on the input or a three-volt bias with one volt peak swing. The one-volt audio signal would give about 12 volts peak output. Not much more signal could be used on the input because of plate overload. The pentode requires about 16 volts peak to give maximum output. Preliminary calculations indicate that about 50 to 60 per cent modulation would be required to give full output.

Method 4. Our first thought to improve the above performance is to place a diode element in the structure and to use this for a rectifier. The rectified voltage could then be applied to the triode and the output of the triode could be applied to the input of the pentode. The performance of this combination would be entirely satisfactory both from the standpoint of sensitivity and ability to give full power output on relatively low percentages of modulation.

Four possible methods of making tubes capable of acting as detector-output tubes have been given.

Method 1. Considerable improvement over a regular output tube is possible by using twin control-grids. The voltage sensitivity as a detector is rather poor and it is impossible to load up the output tube section with low values of modulation.

Method 2. This method is by far the simplest. It has the advantage that bias may be applied to the pentode output grid and that the audio voltage supplied may be controlled. The voltage sensitivity is rather poor and considerable r-f would have to be applied to give full output on low percentages of modulation.

Method 3. A triode used with a pentode would give considerably better voltage sensitivity than the preceding methods. The plate impedance would be rather high so that resistance coupling would have to be used. The modulation percentage required to give full power output with reasonable distortion would be 60 per cent.

Method 4. The use of a diode, triode and pentode seems to be the only solution both as regards output and sensitivity. A minimum of eight connections with nine preferable would be required involving practical difficulties. The complicated tube structure involved would necessarily mean relatively high manufacturing cost. It would be problematical whether or not there would be any saving over two standard tubes.

Notes on the manufacture of

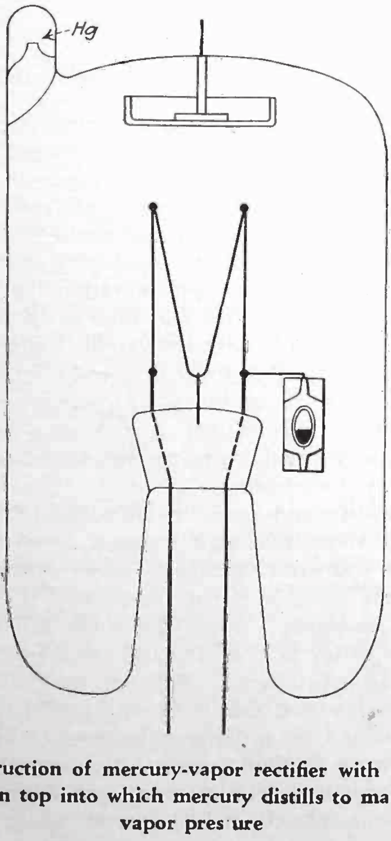
Mercury vapor rectifier tubes

By PAUL G. WEILLER

ONE of the major problems facing the engineer who designs or who uses tubes is that of life. Broadcasting stations which use vapor tubes as high-voltage rectifiers are satisfied with a life of approximately 1,000 hours. Many industries, however, have set their minimum life requirement at 5,000 hours, with a premium on extending the period of usefulness of the tubes to over 10,000 hours.

Such requirements are quite reasonable.

When tubes are used in elevator control for instance, expert supervision in many cases is not available. Changing tubes at frequent intervals is quite inconvenient, particularly when failure of a tube will cause the elevator to stop in the shaft between floors. The resulting impression on passengers is apt to create distrust of the particular make of elevators.



Construction of mercury-vapor rectifier with receptacle in top into which mercury distills to maintain vapor pressure

There are uses for tubes where reasonably frequent changes are of no particular detriment. Equipment manufacturers, however, are loath to use tubes which would have to be replaced before any other parts of the equipment wear out. It is also true that there is a prejudice against using anything made of glass in connection with heavy machinery, a prejudice indulged in by engineers who are not accustomed to tubes. It is a potent factor which added to other factors, makes 5,000- and 10,000-hour tubes necessary.

Different technique is necessary when designing and making tubes of this life. In fact, so different is it that many of the current connections and practices of vacuum tube practice must be done away with.

The life of a mercury vapor tube depends on a variety of factors. Some of them are well known. Others are still enveloped in a good deal of mystery.

If a vapor tube is designed and exhausted properly failure after lapse of the normal period of life is caused either by disappearance of the coating from the base metal of the filament or by destruction of the base metal itself at a point near one end of the filament. The former type of failure is found most frequently with tubes with generous filaments, say 60 watts used for filament heating for each ampere mean d-c plate current. The latter type of failure is common to tubes where the filament is heavily loaded, for instance in tubes with only 10 watts per ampere mean d-c plate current.

The coating process

The disappearance of the coating is evidently due to evaporation either of the oxides of barium and strontium or the metals themselves, the latter operation caused by electrolysis of the oxides when the tube is in operation. In fact it may be said that, other conditions being equal, the life of the tube is roughly proportional to the amount of coating on the filament. It is obvious then that we must pack the maximum possible amount of coating on the filament, and provide means to keep it there.

The customary process of coating by running the filament ribbon through a suspension of barium and strontium carbonates in a solution of barium nitrate yields tolerable filaments for the smaller types but is inadequate for large filaments because the amount of coating which can be put on uniformly is severely limited by the surface tension and viscosity conditions of the coating suspension. Much heavier coatings can be obtained by shaping individual filaments first and then spraying the coating on.

It is standard practice for receiving tubes to use pyroxylin binders for sprayed cathodes with excellent results. For vapor tube filaments it is, however, essential to reduce the amount of lacquer to a minimum. If the usual quantity of lacquer is used results are not satisfactory. Excellent results are obtained by heating the filament by the passage of a suitable current while it is being sprayed with the customary aqueous coating mixture, the latter drying as fast as it is being sprayed on the filament.

Use of netting as filament base

With the larger sizes of filament it is nearly impossible to prevent partial flaking off of the coating, when nickel ribbon is used as base.

The writer has made it a practice during past few years to use netting as filament base with very excellent results. The coating surrounds the individual wires and fills the meshes. If the coating process is properly carried out there is no flaking whatsoever.

In deciding on the proper amount of coating several factors have to be considered. Coating is a good heat radiator in spite of its white color. Up to a very definite limit the heat dissipation of the filament increases with increasing coating weight. The filament would therefore run colder unless it is shortened. If the coating thickness is further increased, heat conduction from base to surface is insufficient. The base runs too hot, the surface too cold.

The proper amount of coating presumed, the life of the tube is dependent on the ratio between mean plate current and filament wattage. The more generous the filament, the longer the tube life will be.

Relation between gas pressure and life

Another factor seriously affecting tube life is the operating pressure of the mercury vapor. The latter is in a general way dependent on the temperature of the coldest spot of the glass envelope. Too great reliance may not be placed on this principle for tubes of relatively small bulbs.

Since the movement of gases at a pressure of a few microns prevalent in properly dimensioned mercury tubes is very sluggish, establishment of an equilibrium between evaporation and condensation of the mercury takes an appreciable time. Consequently the pressure prevailing in some parts of the bulb may be higher than at the coldest spot. The vapor pressure over a mercury drop may for the same reason be higher than required by theory.

For long life it is important to keep the vapor pressure very low, the temperature of the bulb considerably less than 100 deg. C. Unless other means are employed to lower the vapor pressure, this means inconveniently large bulbs. The writer has obtained excellent results by providing a small trap on some convenient part of the bulb which is so placed as to keep cooler than the bulb itself, as shown in the figure. During the seasoning process the mercury distills into the trap and remains there during operation. No mercury remains adherent to the bulb walls.

By this means the vapor pressure always corresponds to the temperature prevailing in the trap which can easily be kept sufficiently low. It is significant that it takes several hours to distill a fraction of a gram of mercury from the bulb into the trap through an orifice of $\frac{1}{8}$ in. diameter. On some types of tubes the increase in life obtained by this design feature amounted to 500 per cent.

For very large tubes proper cooling must be provided by an air blast or by cooling in an oil bath. For long life vapor tubes should be designed either with low voltage filaments or with indirectly heated cathodes.

The drop in vapor tubes measured with d.c. is from 6 to 12 volts dependent on vapor temperature and pressure. If the filament voltage is 5 volts it is obvious that one end of the filament will be idle while the bulk of the discharge will be crowded towards the other end. This effect is aggravated by the fact that the resistance of the positive column decreases when the discharge is concentrated in a narrow path.

Under improper conditions the discharge will concentrate within one-quarter of the filament length, The filament will then deteriorate very rapidly, presumably because the base metal is caused to sputter by intensive positive-ion bombardment. The discharge under such conditions is sea green with a very bright sheath surrounding the filament. When filament and bulb are of the best proportions the discharge is purplish or pure blue. It is obvious from the aforesaid that the filament voltage of the larger types of tubes which run hot should not be over 2½ volts.

If a vapor tube is properly exhausted and operated high inverse peak voltage does not affect its life, as long as no breakdown occurs. The breakdown in the non-conducting direction of a well-designed tube is above 35,000 volts on the test stand. The breakdown voltage is however materially affected by the prevailing vapor pressure. For the highest operating voltages (20,000) it is necessary to design the bulb of ample dimensions. Cooling can be made more effective by providing a trap and by a fan or oil bath. The spacing of the electrodes apparently does not affect the breakdown voltage.

Designers of equipment with which mercury vapor rectifiers are associated should note that the breakdown potential is severely affected by even slight radio-frequency fields. Even the small radio-frequency discharges generated by the spark or arc when an inductive circuit is broken by a switch may be sufficient to cause breakdown and destruction of the tube. It is also to be remembered that the wave form of the rectifier output may contain some radio-frequency harmonics.

These are caused by the straight sides of the wave produced by the constant drop across the rectifier and by a slight peak produced by the fact that the starting voltage may be slightly higher than the operating drop producing an abrupt wave form.

Wave form distortions may also be caused by the effect of the magnetic field produced by the heavy filament current on the electron stream. The rectifier may also go into actual oscillations due to a combination of design features and peculiar circuit conditions. If frequent breakdowns are experienced in some transmitters they should not always be blamed on faulty tubes. Breakdown ratings of vapor tubes should therefore be taken *cum grano salis*.

Long life, the reward of many items

Generous ventilation or forced cooling will safeguard against the effect of high temperature, proper r.f. chokes in the plate leads and shielding with copper screen will help prevent breakdowns because of radio-frequency fields where extreme voltages are required.

In describing the conditions conducive to long life we have always limited our consideration to "properly" exhausted tubes. Long life and high breakdown potentials are attainable only with thoroughly exhausted tubes.

The small 866 rectifier must be given a more thorough treatment than receiving tubes. Amounts of gas which would not materially affect a receiving tube would noticeably lower breakdown potential and tube life in a mercury vapor rectifier.

Extra long life and freedom from breakdown are the reward of a most thorough exhaust, comparable with that of large transmitting tubes. Such a high degree of exhaust is not possible if the mercury is present in the tube during exhaust. When the tubes are exposed to the high frequency field of the induction heater a heavy ring discharge is produced. So much energy is absorbed by the ionized vapor that sufficient heat to soften the glass is produced on prolonged treatment.

The following method permits any desired degree of exhaust without interference from that source. A drop of mercury is placed in a narrow glass tube and exhausted. The mercury is heated to remove absorbed gases. The glass tube is then sealed off short. This glass enclosed mercury drop is placed in a small nickel cylinder and welded to a part of the tube structure.

In this way the tubes can be exhausted to any desired degree without trouble. The nickel cylinder is then heated with the induction heater. The glass within softens and releases the mercury. A few minutes' operation of the tube on the pump will evaporate the bulk of the mercury, the vapor effectively sweeping out any gases evolved from the glass. The tube is then sealed off. Very little mercury remains in the tube. As there is no appreciable disappearance of mercury during operation the minutest drop of it is sufficient to furnish vapor for normal operation.

Except for the high voltage rectifiers for use in transmitters no hard and fast standards have as yet been evolved for mercury vapor tubes. The great variety of specifications to which they must be built have prevented fixing of such standards up to the present time.

The desire to make equipment small and compact, is in the way of using sufficiently large bulbs; the desire to put equipment in cans or steel boxes militates against proper ventilation. Prejudice against glass gadgets does the rest to make life hard for the vapor tube designer.

If the equipment designer can be persuaded to design his device around a tube instead of forcing a tube into a device not designed in accordance with tube practice we can furnish tubes with up to 500 hours life.

With improvements in filament and cathode construction which are in the offing nothing will stand in the way of making steel-envelope hot-cathode tubes for one thousand amperes or more. Considering that such tubes can be used for several thousands volts it is not difficult to see what large powers can be handled with relatively small tubes. The hot cathode rectifier will compare with the present steel tank mercury vapor rectifier as the steam turbine does with the mastodonic Corliss engine.

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BOOKS ON ELECTRONIC SUBJECTS

Einführung in die tonphotographie

(elements of the photographic recording of sound)

By Dr. John Eggert and Dr. Richard Schmidt. Published by S. Hirzel, Leipzig 1932. 137 pages, 122 illustrations. Price R.M. 7, unbound.

IN THE FIRST TWENTY pages a brief review of the properties of sound waves is given; sound amplitude, energy and loudness as measured in dynes and decibels are explained. A similar second section deals with the principal methods of sound recording and sound reproduction. Then the main subject of the book is introduced by discussing the blackening curve of the developed photographic plate, that is, the curve showing the logarithm of the reciprocal of the transmitted light as a function of the light received by the plate. It is shown how two of the three parts which form this curve lead to two distinct methods of recording, the lower or curved portion with variable slope to toe recording, and the middle or straight portion of slope gamma to straight line recording. Faithful recording is obtained when the products of the gamma of the negative and positive film is equal to unity. The choice in film material, however, is limited because the positive film is by agreement a film with gamma equal to 1.8 in its straight portion. These two conditions furnish the starting point for a detailed comparison of faithful recording by the toe and straight-line method for variable density and also for variable films. The book concludes with chapters on noiseless recording, frequency response of the film material and a description of 6 different kinds of Agfa films.

A remarkable feature of the book is the very skillful way in which the illustrations render the text clearly understood. Moreover as many subjects in the book correspond more or less closely to material which has been discussed in *Electronics* (see *Electronics* February and March, 1931, February 1932, etc.) the book can probably be read with profit even by those engineers who have only a limited knowledge of German.

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Table of arc spectrum lines 2785 to 3505 A.

By Welton J. Crook, published by Stanford University Press. 30 pages.

THE PERFORMANCE OF MANY electronic devices depends on the purity of the materials used. The detection of small amounts of impurities in metals has become a speedy and certain matter through the recent application of spectroscopy to chemical analysis which allows the approximate concentration to be determined, that is, whether for instance 0.001 or 0.01 or 0.1 per cent of thorium or iron is present in tungsten. The author gives a table of 6,630 wavelengths for this work which are nearly complete as regards copper, molybdenum, nickel, platinum, tantalum, tungsten, zirconium and many other elements. He regrets that no numerical standard of line intensity exists, but he could have indicated the approximate relationship or the excitation voltage of the lines, which are often a more reliable guide than the intensity. Also in view of the fact that iron is often used as the comparison source, it would have helped to print the iron lines in heavier type. It may be mentioned in passing that the Osram has developed a standard lamp with iron electrodes containing substances which give off electrons at a low red heat so that the lamp can even be run from 110 volts a.c.

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Photocells and their application

By Zworykin and Wilson. Second edition, 329 pages, John Wiley & Sons, Inc. Price, $3.

THE SECOND EDITION OF THIS popular book is much more than a simple revision; it is longer by some 125 pages and five chapters. The old matter has been rewritten to a large extent and new information has been included. As an example, the chapter in the first edition on photo-conductive and photo-voltaic cells has been divided into two chapters and of course greatly enlarged. A chapter giving comparative outputs of the various types of light-sensitive cells is included.

Material on the construction and the mechanism of the photocell is given. Vacuum cells, gaseous cells, copper-oxide cells, selenium cells and so on, all are carefully treated. The approach is that of the engineer rather than the scientist. Therefore the book is practical and deals with circuits and industrial uses of the phototube as well as its application to motion pictures and to television.

With all their faith in the photocell as a tool of potential industrial importance the authors do not lose sight of the fact that the tube has certain limitations. These are pointed out.

Photometry, color matching, color analysis, and applications in which the grid-controlled rectifier is used are handled in a manner any engineer can understand.

HIGH LIGHTS ON ELECTRONIC

Web control of printing press

The New Britain (Conn.) Herald press has four decks—that is, four independent sets of rolls for printing on newspaper stock. This paper stock (referred to as the "web") is fed through the various rolls from four separate rolls of paper. After passing through the printing rolls the four separate webs are brought together in a folder which folds and cuts the newspaper into the finished product.

If one of these webs breaks while the press is running at high speed, the web wraps around the printing cylinder, and if the press is not shut down immediately, so many layers wrap that the added thickness destroys the rubber covering or "blanket" of the roll which backs up the type. The blanket costs over a hundred dollars to replace and, of course, the printing of the paper is held up.

To reduce the number of wraps to a minimum, four photoelectric units have been installed on the press, one to watch each of the four separate webs passing through it.

Each unit consists of a sheet-metal case containing a phototube and a 40-watt lamp of the 110-volt house-lighting variety. The lamp shines on the paper and the reflection is seen by the phototube. A partition inside the case prevents the light from shining directly on the phototube. This partition is a part of a hinged cover, however, and when the cover is tilted back, it allows the light to fall directly on the phototube, thus rendering the unit inoperative as far as reflected light is concerned.

The four phototubes are connected in series with one relay, so that darkening any one of the cells opens the photoelectric circuit and the contactor which controls the press motor falls out.

Since breaking of any of the webs will remove the source from which the phototube gets its reflected light, the press stops instantly upon the occasion of a break.

There are several variables which might affect the operation of the phototubes, and they include,

1. Whether the paper has been printed upon at the particular station being watched.
2. If the edition is small on a particular day, one or more decks may not be in use and the hinged cover will be tilted back, allowing the full light to fall on the tube.
3. Lamps and phototubes may be dimmed by dirt.
4. Lamps may become dim with age.
5. The caesium tube used varies in sensitivity.
6. The blackness of type varies—that is, large black advertisements may appear on one page and not another.
7. Since part of the reflected light comes from the general illumination of the room, it will vary with the weather, the time of day and the time of year.

A unique feature of the installation is the control of all these variables from a remote knob situated on a pillar of the press within easy reach of the pressman.

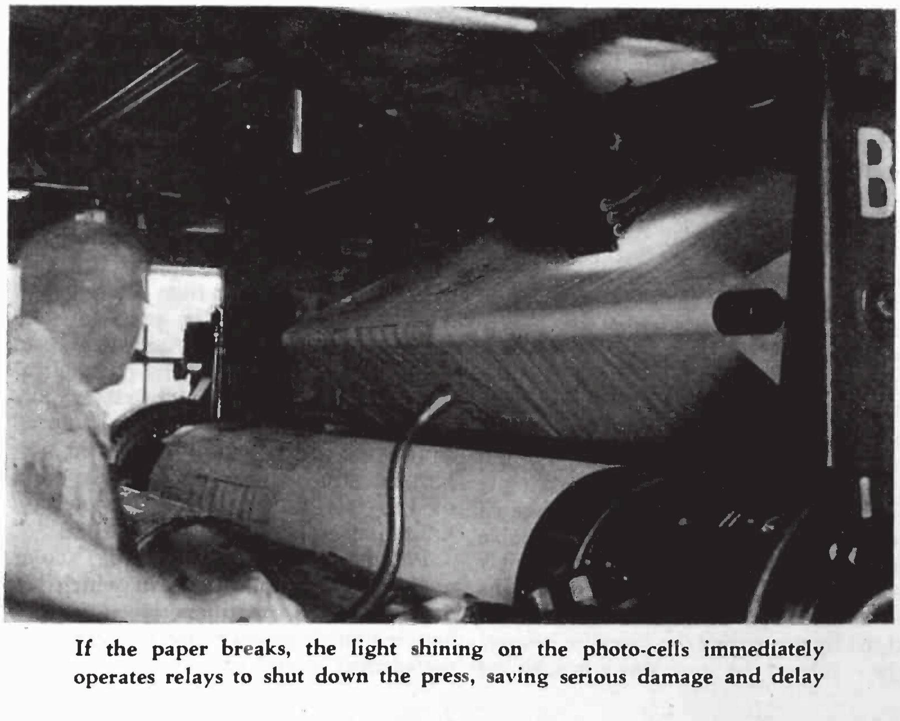
Since all these variables are transmitted to the one amplifying tube of the relay, a milliammeter placed in the plate circuit will show the resultant of the reflected light on the four phototubes. The remote control box contains a milliammeter on its face and below it, a control knob attached to a potentiometer for adjusting the grid bias of the tube.

When the edition is about to be printed, the press is started and the milliammeter observed. If the reading is too high or too low, the pressman turns the knob until the pointer of the milliammeter falls on a red mark placed at the point of most satisfactory operation. No further attention is then necessary.

Thus, all variables are compensated for each day and no service has been required on this installation. Each break has been faithfully caught for many months.

In addition to the electrical control of the press motor, a motor-driven brake mechanism was designed and installed on this press, working in conjunction with the photoelectric relay, so that whenever the press is stopped, either by the breaking of the web or by pressing the stop button, each of the four heavy rolls of paper is stopped. This prevents over-running, with consequent tangling of the web in other parts of the press.

The rolls of paper were already equipped with hand-operated brake shoes for controlling the tension of the paper. An automatic lever mechanism was added to the existing shoes connected to the main motor-operated braking unit by individual cables. The main braking unit includes a 165-pound weight, which drops down, pulling on the cables as soon as the electrical impulse from the photoelectric relay reaches it. The motor pulls the weight up again and releases the brakes to avoid breaking the web as the press comes to rest.



If the paper breaks, the light shining on the photo-cells immediately operates relays to shut down the press, saving serious damage and delay

✦

Ounce crystal mike carried on fish-pole

The new crystal microphone has come in very handy for sound-picture crews taking photographs on location. Formerly a substantial and bulky microphone-crane was necessary to swing the usual heavy microphone over the heads of the actors, but out of sight of the camera lens.

Now with the new crystal microphone, which is so light it can be mailed at minimum letter postage, only a slender fishing pole is needed to carry the mike over the heads of those taking part in the scene.

DEVICES IN INDUSTRY + +

Bar and rod heating controlled by electric eye

Welding heaters equipped with photocells and amplifier tubes as well as with timing devices, as built by the American Car and Foundry Company were exhibited at the recent New York Power Show. The operator sets the control for the color produced by the desired temperature; when the steel is heated to the desired temperature, the operator is warned by a red light or a bell. Hourly capacity per electrode ranges from 200 ⅜-in. pieces 1½ to 2 in. length of heat, to 20 ⅜-in. pieces 1½ to 2 in. length of heat to 20 1½-in. pieces having 3 to 4 in. length of heat. Electric rivet heaters and valve-stem heaters are also available with electric-eye control.

◆

Measuring pressure and weight

Several schemes available for measuring pressure were described by Prof. Harold C. Weber before the Boston Section of the American Chemical Society. The one used to determine the pressure existing in large guns, during firing, involves a quartz crystal which is compressed by the pressure. Pressure exerted on opposite faces of the crystal generates an electric charge, whose magnitude is almost directly proportional to the pressure applied.

To amplify and record the pulse is a simple job for the vacuum tube amplifier. An apparatus used by the author for measuring pressures of about one thousandth of an inch of water consisted of an oscillator whose grid circuit condenser was so designed that a small pressure caused a slight movement of one of the condenser plates. This movement caused a change in frequency of an oscillating circuit which had been previously calibrated for various pressures on the condenser. The device was entirely self contained and portable and in one model read directly in inches of water.

For measuring very low pressures of the order of those measured on a McLeod gage, the ionization manometer consisting really of a three electrode tube whose jacket is connected with the space under measurement, has found frequent use. This gage is said to be more reliable at the lower range than is the McLeod gage.

By building the grid circuit condenser of a tube oscillator in such form that one plate deflects under the load to be determined or is displaced by the thickness of the material under measurement a change of frequency in the oscillator will occur. Measurement of the frequency change gives a method of measuring the weight or thickness. Deflections of a millionth of an inch are easily determined by the method and in one commercial thickness gage of this type a variation of two millionth of an inch in a piece over an eighth of an inch thick causes such a large deflection on the recording meter as to throw the instrument off scale.

◆

River marking lights photo-cell controlled

The U. S. Lighthouse Service now makes use of photoelectric cells to control its river marking lights, and has recently installed nine Weston units on electric-battery markers along the Connecticut River. These cells turn off the battery-operated lights as soon as dawn comes, and turn them on again when darkness falls, thus doubling the former useful life of a single battery charge. The circuit is arranged to take no current when the lights are on, but to take a small control current with lights off.

Controlling of water supply

To Keep Watch Over the health of the people is a new duty of the "electric eye" described by J. V. Alfriend, Jr., of the Westinghouse company.

The cell automatically regulates the amount of chlorine that is liberated as a germ killer into the water supply of cities. Its action is prompted by color changes.

"The first or 'balanced bridge' arrangement," Mr. Alfriend explains, "utilizes two light sensitive photo tubes simultaneously to inspect the light transmitted through a sample of the unknown liquor and the light transmitted through a standard colorimetric sample representing the desired quantity of the variable chemical. The second or 'null' method uses a single photo tube inspecting simultaneously the light transmitted by the unknown sample and the known sample."

Similar automatic photoelectric control has been applied to maintaining the acidity of paper mill stock solutions, holding the proper amount of sand in coal washing water, and in regulating the acidity of the electrolyte in electrochemical industries.

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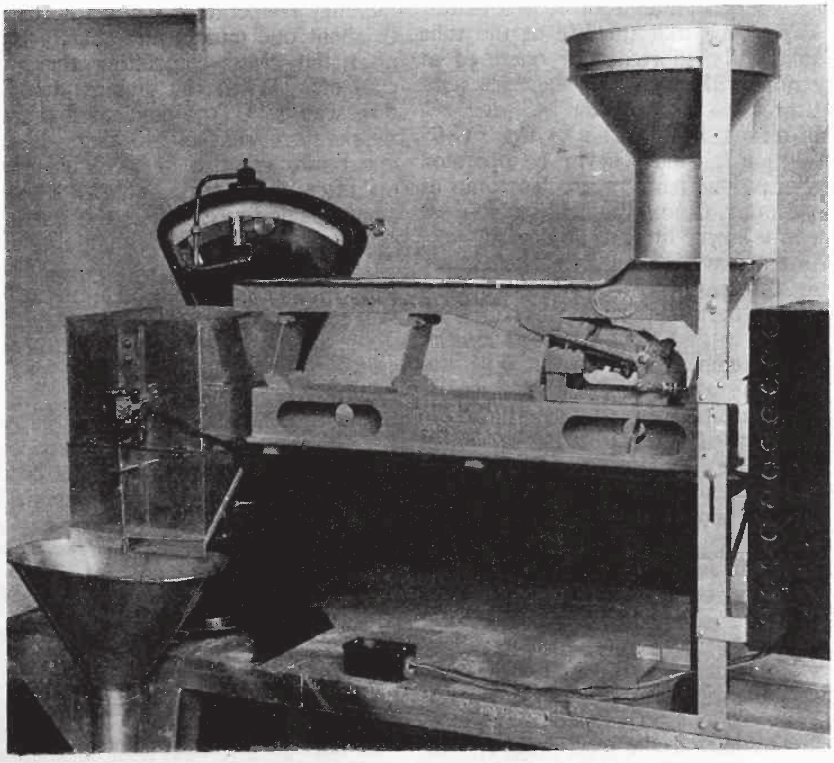
AUTOMATIC PHOTOCELL-CONTROLLED SCALES



This is the Toledo vibrator filling machine. It automatically weighs out predetermined amounts of dry materials in packaging or blending operations. The vibrator shakes the cereal or prunes onto the scale; a photocell cut-off stops the flow when the required quantity is reached

+ + + ELECTRONIC NOTES

Device for temperature regulation of mercury vapor tubes

By C. Stansbury and
G. C. Brown
Cutler-Hammer, Inc.

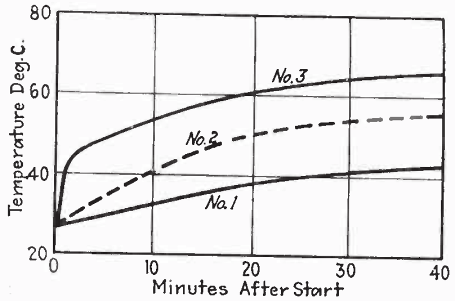
A very important point in the use of mercury vapor tubes is the fact that their characteristics and life are dependent on the ambient temperature at which the tube is operated. The tube contains mercury, which is partly in the form of vapor and partly in the form of liquid condensed at the lowest point of the bulb. The temperature of the liquid mercury at this point determines the vapor pressure throughout the enclosure. On the vapor pressure in turn is dependent the voltage necessary to drive a given current from anode to cathode which is a vital factor in connection with the rate of deterioration of the tube in service. Also affected is the value of anode voltage necessary to start an arc at a given grid potential which affects performance of devices dependent for proper operation on reasonable stability of this characteristic.

A thermocouple taped against the bulb just above the upper edge of the base appears to give a temperature slightly higher than the actual condensed mercury temperature but it is sufficiently accurate for most practical purposes. For reasonably stable control at least 40 deg. condensed mercury temperature is necessary. In addition it is a matter of experience that the life of the tube is materially shortened if operated at any time with condensed mercury temperature less than about 45 deg. C. This means, in the case of the FG-65 tube, that it should never be operated at an ambient temperature less than at least 15 deg. C. and the makers have set a definite lower limit of 20 deg. C.

As ambient temperatures much lower than 20 deg. C. are commonly encountered in industrial applications, it is necessary to find some way to keep the ambient temperature surrounding the tube always above this minimum.

Experiments with a small heater located near the base of the tube which, although not having anywhere near enough watts to heat up the whole enclosure, disclosed that it was possible to warm a current of air which would pass up and surround the tube and raise its ambient temperature just as effectively as if the whole enclosure were heated. The arrangement proved to be practicable, but also showed the necessity for thermostatically controlling such a heater to avoid excessive temperature under summer conditions. Curve one of the performance may be taken as the general ambient temperature inside the enclosure, curve two is the temperature on the tube side of the thermostatic strip which controls the heater, and curve three shows the approximate condensed mercury temperature. The controlling thermostat is located just as close to the bulb at the point just above the base as is practicable in order to make its temperature correspond to approximately the condensed mercury temperature. The ideal control of the heater would doubtless be by means of a device which would respond accurately to condensed mercury temperature, but the approximate correspondence here obtained is sufficiently good for the purpose.

To protect the tube until it has had time to warm up to operating temperature, a thermostatic strip timer is used, which keeps open the cathode return circuit for from one to two minutes with the FG-65 tube and for longer periods in case of larger tubes. The condensed mercury temperature reaches 40 deg. C. in about one minute and shortly thereafter the heater-controlling thermostat cuts off. When the ambient temperature was 8° C. the condensed mercury temperature reached 40 deg. C. after about two minutes and the heater cut off after about six minutes. The ambient temperature inside the enclosure did not reach the nominal safe value of 20 deg. C. for eleven minutes, but in spite of this fact the local heater raised the condensed mercury temperature of the tube to a safe value within the permissible warming up period of two minutes.



In general, if the enclosure is not very large the ambient temperature inside the enclosure will ultimately exceed 20 deg. C. except under excessive conditions, after which there is no longer any call for the heater.

Magnetostriction oscillator

Intense audible sounds produced by a magnetostrictive vibrator are described in *Physics 3: 209-229, 1932*, by Newton Gaines, University of Texas.

The vibrator consists of a cold-drawn nickel tube ¾ in. in diameter and about 26.4 cm. long, sticking with its upper half into a water vessel, and closed at its upper end by a thick nickel plate welded to it. The lower half is surrounded by the coils by means of which oscillations of the frequency 8,900 cycles are maintained with the aid of a UV 204-A. A cork firmly driven into one end of the nickel tube quickly becomes hot at its center owing to the absorption of sound energy. The nickel tube itself is eventually broken near the middle. Metal and glass surfaces held under water show traces of erosion. Bacteria are killed.

Quartz-rod electronic precision clock

A precision clock has been constructed by A. Scheibe and V. Adelsberger, German National Physical Laboratory. As described in *Zeitschrift techn. Phys. 13, 591-593, 1932*, it comprises a quartz rod 1.5 by 3 by 91 mm. in place of a slab as in Marrison's crystal clock as the mechanical vibrating system. The rod oscillates in its second harmonic (longitudinal) frequency, 60,000 cycles per sec., it is placed between grid and cathode of a commercial vacuum tube, and excites oscillations in the tuned anode circuit. These oscillations are amplified in a resistance-coupled stage and then in a tuned stage. After the frequency has been reduced to 333 cycles per sec. it is made to operate a synchronous motor. During a period of six months the quartz clock remained constant to within +0.002 second.

Low voltage photoelectric colorimeter

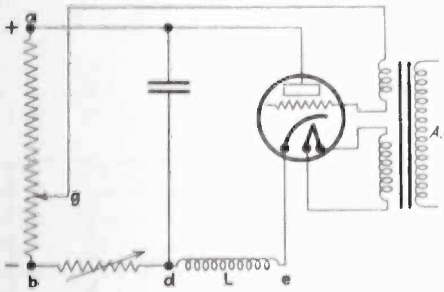
B. Lange, of the K. W. Institute, Berlin, describes a very compact photoelectric colorimeter in *Die chemische fabrik 5:457-459, 1932,* and in *Zeitschrift für techn. Physik, 13:600-606, 1932.* Two detector-type photoelectric elements (cuprous oxide, selenium layer, etc.) were used in two arms of a Wheatstone bridge, a potentiometer forming the two other branches. The sliding contact on the potentiometer is connected to the shunted measuring instrument, and from there to a point between the two cells. No external source of potential is required. Light from a small lamp passes through glass cells one containing a standard solution, the other the solutions whose color or turbidity has to be measured. For ordinary purposes a microammeter is sufficient (see measuring acidity and alkalinity by photocell, *Electronics,* July, 1932).

FROM THE LABORATORY + + +

A new electronic tool—the discharging condenser

Application of grid-controlled rectifiers to welding calls attention to the use of a condenser-resistor combination to control the rate at which a phenomenon is permitted to take place. The discharging condenser has been used frequently in the laboratory; practical uses have been the control of street traffic lights, and this new application brings added importance to a natural electrical phenomenon.

In the welding equipment, the grid-controlled tube is used to effectively short circuit the secondary of a series transformer. When this occurs the reactance of the transformer becomes very low and nearly full current is passed to the welding circuit. The number of cycles during which the tube shall pass current, and the period of each cycle during which the tube shall be non-conducting or conducting are of importance.



Some sort of timer, therefore, is necessary. Again the grid-controlled rectifier comes into service. In the figure when d.c. voltage is impressed across a-b the voltage across the condenser is at first zero and therefore the anode and cathode are at the same potential. The grid is negative with respect to the cathode. As the condenser charges the anode becomes positive, and the grid somewhat less negative. At some critical value of these two voltages the tube will pass current discharging the condenser whence the cycle can begin again.

The voltage between *g* and *d* is constantly varying between the voltage determined by the position of the slider *g* and the charge and discharge of the condenser and this cyclically varying voltage can be put to varied uses. The rate at which the condenser charges is controlled by the value of the resistor *b-d*. The adjustment of the oscillating circuit controls the time the tube is on or off in cycles, the position of the slider *g* determines the relative portion of the cycle the tube is on or off.

In practice a small a-c voltage is put on the grid of the timer control tube to aid in maintaining synchronous timing.

Velocity of sound in paper

Measurements on the velocity of sound in paper were made by D. A. Oliver, Northampton Polytechnic, by fixing a strip of paper in a vibrating clamp and noting the resonant frequencies for various length of overhang. The velocity was found from these paper cantilevers is 2.1×10^5 cm. for white Bristol board paper, 0.017 cm. thick and 1.8×10^5 cm. for brown corrugated paper 0.047 cm. thick. The measurements are reported in *Philosophical Magazine* and *Journal of Science*, August 1932, and seem to be in good agreement with those assumed in loud speaker work.

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Gas-filled photocell inertia

In experiments conducted by F. Ollendorff of the Institute of Technology, Berlin, light from a point arc was allowed to fall upon gas-filled commercial photocells (General Electric type) after having passed through a rotating scanning disk which caused up to 60,000 interruptions per second. The photo current as measured by the potential drop across a moderate resistance decreased as the frequency was increased from zero to the point where 30,000 interruptions were produced, but it began to increase again between 30,000 and 60,000 complete cycles. The theory *(Zeitschrift für techn. Physik B:606-611, 1932)* of the ionization currents produced in the cell shows that the current assumes high values when the frequency of the modulated light beam is a multiple of v/d (v = velocity of positive ions, d = distance between electrodes), that is when the positive ions produced near the plate arrive at the cathode during the peak of the illumination. Low values are obtained when the arrival coincides with the darkened period.

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Photoelectric U-V photometers

Considerable work has been done to adapt the photocell to the photometry of sources of ultra violet light. In regions where the eye is not sensitive or where the eye would suffer from exposure to the energy, some means such as a light-sensitive surface forms an elegant method of making comparisons or quantitative measurements. In addition to the list of ultra violet photometers listed below, an instrument using photocells for application to photomicrography has been put into service at the Mt. Sinai Hospital, New York City.

Ultraviolet photometers utilizing the photocell are in use at the Bureau of Standards, the Department of Public Health, and the Department of Agriculture in Washington. Other units are owned by the American Medical Association, and several photometers are in use in hospitals in Cleveland and Pittsburgh. These units have been manufactured by Westinghouse after the research work of Dr. H. C. Rentschler. The Mt. Sinai installation was made by Dr. E. E. Free.

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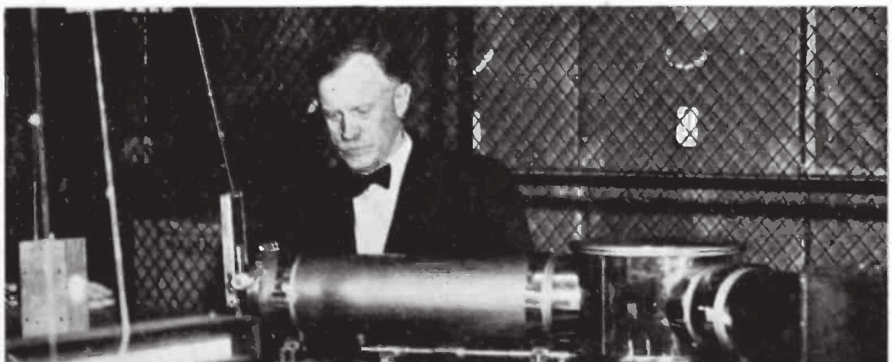
TO AID RESEARCH IN THE ULTRAVIOLET



By means of this monochromater recently completed at the Nela Park laboratories by Dr. W. E. Forsythe it is possible to select one wave-length of light from the spectrum and measure its characteristics fully. This device is used to study the ultraviolet, visible and infra-red radiation from various light sources

BACK TO QUALITY

An Editorial

NEARLY one million dollars a week is spent on bringing to the radio listening public the best program features and talent that money can buy. Additional millions are being invested in broadcast-transmitter equipment, so that broadcasting of the uttermost fidelity and tone-quality may drench our principal centers of population.

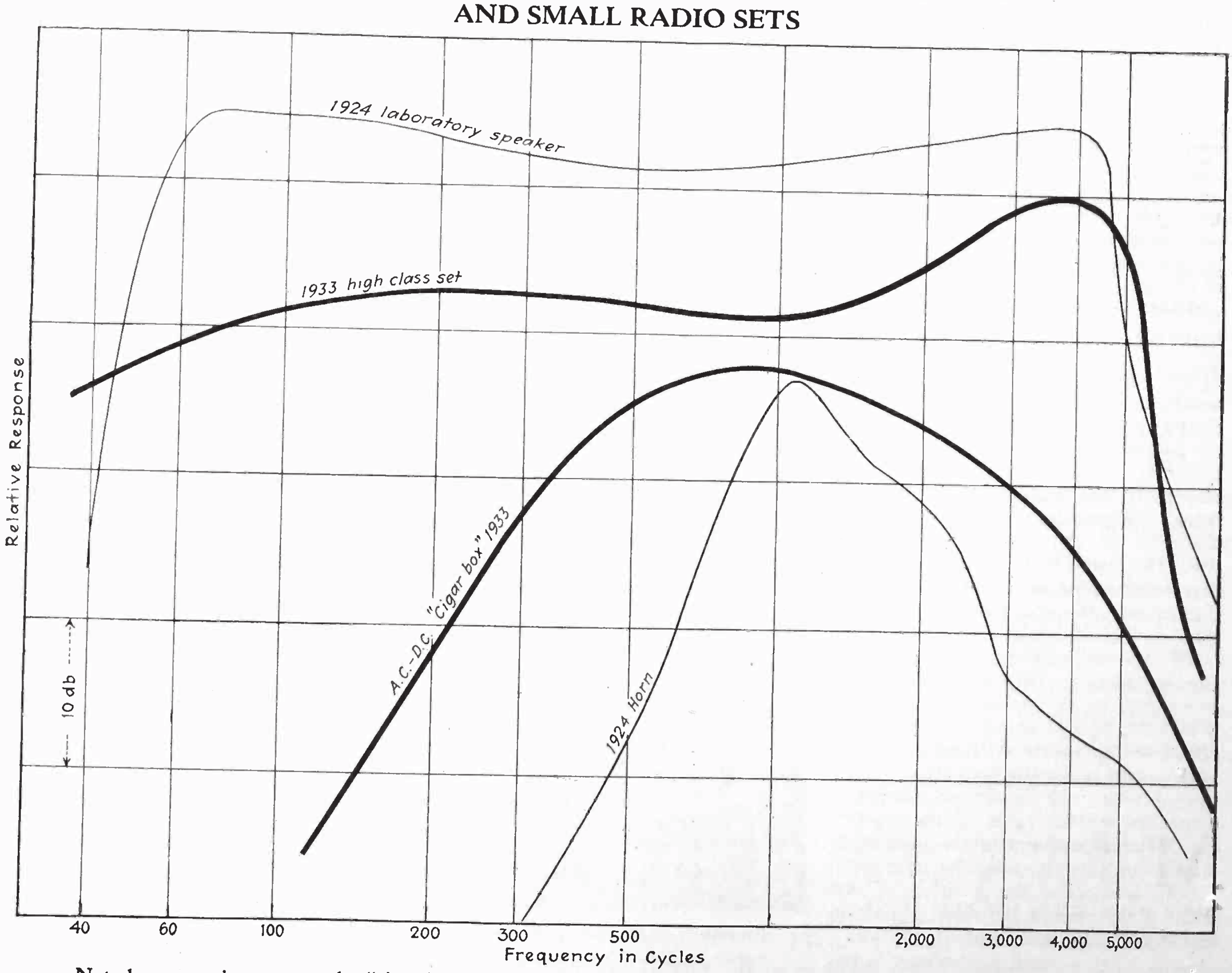
Yet steadily the average of our *receiving sets* grows worse and worse,—more and more deficient in quality of reproduction, inadequate in material equipment and durability.

Of course there are still citadels of radio quality. There are still organizations where skimping and chiseling of material and tone will not be permitted.

But the great volume of the receiving sets poured out upon the market are limited in their tone quality, and whittled to the breaking point in their necessary skimping of materials.

And this sinister chiseling of quality is felt all the way back along the line of supply of parts and constituents. Parts manufacturers have learned that their sales depend upon their skimping in turn, until the last vestige of working load is wrung from the shrieking metal; that they must chisel and then chisel again.

THE WIDE DIFFERENCE IN TONE FIDELITY BETWEEN LARGE AND SMALL RADIO SETS



Note how poor in response the "cigar-box" is and how well the high-class console with its large baffle reproduces the low tones. The relative flatness of these curves is important. The comparative loudness of the sets is not indicated

IN RADIO RECEIVERS!

THE quality of broadcasting stations, of wire lines and repeaters, has steadily improved. In fact, it is almost impossible to sell a transmitter nowadays that is not guaranteed to go up to 7000 cycles or beyond. But on that part of the public that buys the little two and three-octave sets, all this expense is wasted.

The curves shown here demonstrate clearly that the cigar-box sets of today are poorer in quality than receivers of 1928, or even of many built in 1926 and 1927. As long ago as 1925 loudspeakers were available which transmitted to the listener the deep bass which gives power and grandeur to the world's great music. The curves of the small 1933 set shown were recorded in a well known laboratory under standard conditions on a receiver with the following dimensions 24 cm. by 17 cm. by 11 cm., clearly a cigar-box set. The engineers who made the test selected it as being "one of the best of today's ultra-small sets."

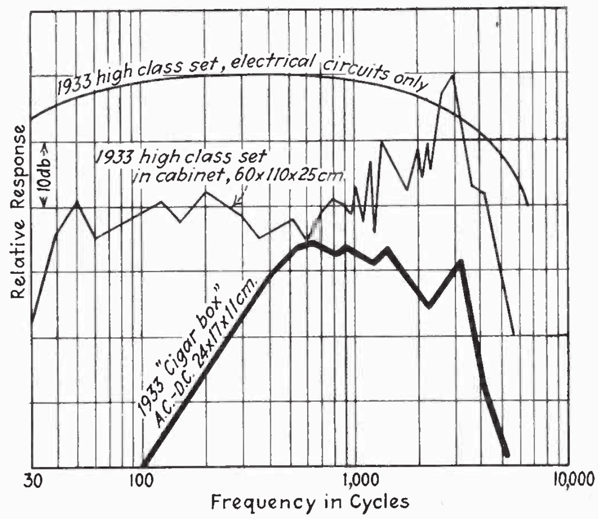
Fidelity of reception is not the only characteristic that has gone by the board in the craze for lower and lower prices. Sensitivity has decreased, selection of receivers in the factory has become so superficial that anything that plays is shipped.

What can be done about this progressive degradation of the radio receiver until the entire broadcast system invites competition from other means of getting high quality entertainment into the home?

There are several steps that can be taken.

The industry must recognize, as it has during the past year, the public demand for small sets. The public, however, must be taught that high fidelity of tone cannot be secured from the cigar-box type of receiver. It is simply a case of insufficient baffle area for the loudspeaker. Clearly then the loudspeaker must be separated from the set, equipped with sufficient baffle area and placed, inconspicuously perhaps, in some other part of the room. This will enable the listener to have his small set and to get high quality to boot.

MORE experimenting along the line of remote control or "lazy man's" radios will determine what form the new type of radio and external loudspeaker will take. Perhaps it will be a single model of chassis but a number of models of loudspeakers sold on the accessory plan.



The dimensions of the two sets are given; only the flatness of the curves count, not the fact that one has been plotted above the other

At any rate the very advantage of tuning and adjusting volume and tone from the point in the room where the listener will sit is of great importance. As soon as the idea is firmly planted that the speaker and the tuning mechanism need not be in the same box, the idea of two speakers will not be difficult to sell. The virtues of two speakers, rather widely separated in the room, is as yet untried commercially, but experimentally has shown itself to be of vast importance in improving tone value and realism. These extra speakers can be inconspicuous and inexpensive and can go in doors, behind sofas, in end tables, behind screens and other places where the tuning part of the radio could not go.

Such removal of the speaker from the set will bring back the bass notes. There will remain the task to improve the high frequencies. Present day sets are remarkably dead above 4000 cycles, despite the fact that the broadcast transmitters are pumping into the ether all frequencies up to and including 6000 and 7000 cycles. To get these frequencies into the home receiver will call for an industry war waged on man-made static. It will call for industry demand that field strength of broadcast stations be improved.

All this is possible. The demand for small inexpensive sets can be turned to advantage. Quality can again become a talking point. It can sell countless thousands of radios still.

REVIEW OF ELECTRONICS LITERATURE

HERE AND ABROAD

The manufacture of photoelectric cells

[G. Dejardin, University of Lyons.] The article describes the parts used for the electrodes and the materials used for the bulb, insisting upon the property of thin glass walls to let pass a considerable amount of ultraviolet (French patent 692,007), methods for depositing the sensitive layers either upon the wall, particularly easy in the case of magnesium, or upon silver or copper disks, which are then treated according to the method described in *Electronics* 5:255, 1932, and describes a few typical cells. The second part of the article is devoted to the methods of preparing the photosensitive layers including the cells for measuring ultra-violet radiations (cadmium, thorium, uranium, cerium). Many articles and over 50 French patents are mentioned.—*Revue gen. El. 33:3-13 and 37-53, 1933.*

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Grid-controlled discharge tubes

[E. Luebcke, Siemens Research Laboratory] The use of grid-controlled electron tubes (ordinary half-wave, and grid-controlled rectifiers) for control and regulation work is examined in the case where the external load is an ohmic resistance. In contrast to vacuum tubes with their high plate potential, grid-controlled rectifiers have a low internal resistance (10 to 30 volts on the plate). Starting requires a positive grid potential which except for very low values decreases linearly with the plate voltage between 400 and about 30 volts so that as in the case of vacuum tubes controlling amplification factors can be defined for different tubes. They vary between zero and eight. The starting points obtained with d.c. can be used to construct the starting curves when a.c. is applied to one plate. Sinusoidal curves result, raised or lowered more or less with respect to one another and nearly flat when the amplification is small. In this latter case the tube can only be used for switching current on or off. If a.c. is applied to the grid, the strength of the average rectified current can be varied in any ratio between 1 and 10,000. A still more flexible control is to be had when a.c. and d.c. are applied at the same time to the grid.—*Zeits. techn. Physik 14: 61-64, 1933.*

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Fight against radio interference

[Michel Adam] It is desirable that the strength of the local stations exceed 2 mv/m, that of the distant stations 1 mv/m, whereas any appliance producing more than ⅛ mv/m at the receiver is to be considered as a source of interference. Progress in the fight against man-made static has been made in 1932 with regard to discharge tubes (rejector circuit in secondary of transformer), screened lead-ins (0.0001 to 0.001 uf per meter length), street-car noises (aluminum contacts being replaced by zinc and carbon; if necessary choke-coils inserted, 24 in. in height and 5 in. in diameter), high frequency medical appliances, elevators, oil-burners.

Out of 300,000 complaints forwarded during 1931 to German radio-inspectors, 35 per cent were due to motors and domestic appliances, 3 per cent to medical apparatus used by physicians and 23 per cent due to those used in the homes, 8 per cent were due to regeneration, 5 per cent to power stations, 6 per cent to street cars, 13 per cent to defective sets, etc. At a recent radio show 44 firms exhibited interference eliminators. Out of 49,000 complaints received by the English authorities in 1932, 37 per cent were caused by high frequency medical devices, 8 per cent by power stations, 15 per cent by other receiving sets.—*Revue gen. Electricite, 33: 247-253, 1933.*

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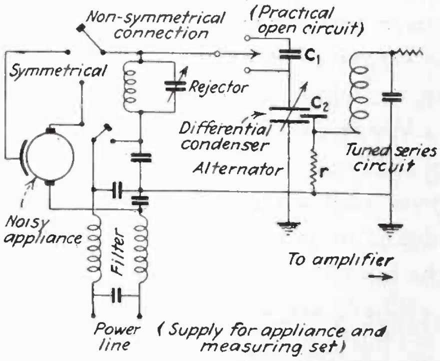
Measuring man-made static

[W. Wild, Committee on man-made static of the Society of German Engineers] Practically all the appliances which become a nuisance owing to sparking emit waves which cover continuously the entire broadcast band, the strength being inversely proportional to the frequency. The measured effective voltage level varies with the square root of the band width. The instrument designed measures the intensity of bands of definite width in the region from 150 to 1,500 kc. and allows the load to be varied from open to short circuit conditions. It consists of connectors to be attached to the terminals of the appliance (symmetrical connection) or to one terminal and the body (housing, support) of the noisy machine (unsymmetrical connection). Then follow a rejector circuit, an attenuator 1:1,000 by means of which the load can be varied, a tuned circuit, an aperiodic r-f amplifier (4 stages), the main band-pass filter with a dynatron for introducing negative resistance, a second aperiodic r-f amplifier (2 stages), then either an r-f vacuum-tube bridge voltmeter for measuring steady disturbers or an impulse meter for intermittent noises. The damping due to the instrument varies very little between 200 and 1,500 kc. Curves show the complex resistance of a vacuum tube cleaner spark and a warm air drier at different r-f—*Elektrotechn. Zeits. 54: 149-152, 172-175, 1933.*



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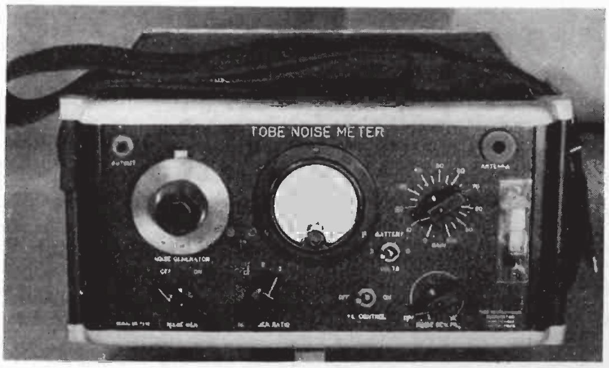
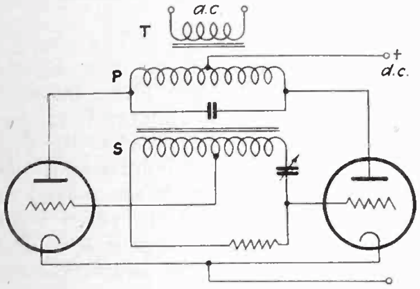


Radio set for locating source of man-made static (Tobe Deutschmann)

Inversion by means of grid-controlled rectifiers

[H. Fruehauf, General Electric Co., Berlin] The inversion d.c. interests the radio engineer because it offers a simple means of obtaining a.c. for the batteryless set in districts where only 110 volt d.c. is available. The transformation is based upon the sudden drop in voltage which occurs when the discharge starts in one of the two thyratrons mounted in parallel with (between the plates) a center-tapped transformer shunted by a condenser (center-tap positive, cathodes negative). The impulse produced in the transformer sends a reverse current through the tube which is operating and interrupts the discharge, the sudden discharge of the condenser provides the voltage necessary for controlling the grid (transformer secondary) and the desired a-c power (tertiary). It is possible to draw 100 watts from a glass tube of ordinary rectifier size, but the shape of the wave leaves much to be desired (see also *Electronics, April, 1931.)—Radio-Helios 10: 9-12, 1933; also A. W. Hull in Physics 4: 66-75, 1933.*



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High-powered transmitters system

[Lorenz.] A typical feature of the Lorenz transmitters (Leipzig 120 to 150 kw., the largest German transmitter, Munich 60 kw.) is the complete separation of the different r-f amplifier stages. Leipzig has seven stages, all housed in metal cabinets several meters apart; the two last stages being in duplicate with the sixth stage consisting of two 40 kw. tubes, the last stage of four 140 kw. tubes. Munich has the same circuit, but the last stage contains only two tubes in all. Both transmitters have wooden towers, and the antenna is suspended 200 m. from the transmitter building.

During spring and summer of 1932 the number of German listeners began to decrease, but the whole year showed a gain compared to 1931, and the high powered stations seem to revive the interest.—*Radio-Helios 10:3-4, 1933.*

Photocells for the ultra-violet

[A. H. Taylor, General Electric Company, Cleveland.] Although many diseases are caused by germs little affected by ultra-violet light, interest in this field continues unabated. Sodium cells in quartz or in Corex D bulbs are frequently used for measuring intensities. In addition the variation of the photoelectric sensitivity (combined with the effect of the glass or quartz wall) of cadmium and titanium cells is shown. Only the cadmium cell is practically insensitive to light waves longer than those producing sunburn, and while it gives a small photoelectric effect a gas-filled cell with a Leeds and Northrup galvanometer is satisfactory in the measurement of the ultraviolet energy in sunlight and sunlamps. — *Journal Optical Society 23:60-66, 1933.*

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Vapor pressure in oxide-coated tubes

[A. Claassen, C. F. Veenemans and W. G. Burgers, Philips' Research Lab.] The vapor pressure of barium oxide is given (in mm. mercury) by $\log p = 8.87 - 19{,}700/T$ between 1,200 and 1,500° abs., that of strontium oxide by $\log p = 13.12 - 30{,}700/T$ between 1,500 and 1,650° abs. In mixtures the vapor pressure depends only on the percentage of the components. Layers of oxide 100 to 200 microns thick deposited upon platinum (30 sq.cm.) were used in this investigation. At a temperature of 1,500° abs., one molecular layer of strontium oxide and 42 layers of barium oxide are evaporated per minute; at 1,100 it takes 120 minutes before a molecular layer of barium oxide is boiled off.—*Zeits. Physik 80: 324-352, 1933.*

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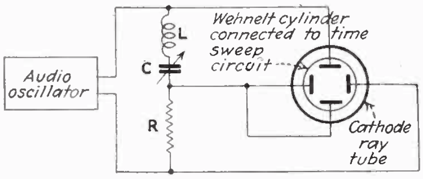
Calibration of microphones

[W. Geffcken and L. Keibs, Breslau Institute of Technology] Report that although the theory of the thermophone commonly used for calibrating microphones (E. J. Abbott, Journal Acoustical Society 4:235-244, 1933) has been corrected on several occasions, it is found that the formula for calculating the sound pressure produced by the electrically heated wire or foil ceases to be valid when the temperature of the conductor is distinctly above room temperature. In Annalen d. Physik 16:404-430, 1933, they deduce a new formula which is in complete agreement with experimental results when applied to the wire thermophone. This type of thermophone, which has cylindrical symmetry, is useful on account of its constancy. The formula was checked by studying the threefold intensity of hearing.

Modulated deflection of cathode-ray beam

[H. E. Hollmann and W. Saraga, Heinrich Hertz Institute] When a-c curves are studied with the aid of the cathode-ray tube, an alternating analyzing voltage being applied to the deflection plates, the shape of the figure obtained is independent of the sign of the phase difference between the two voltages. The direction in which the figure is written changes with the sign, but it is difficult to follow the beam even at fairly low frequencies. The sense in which the curve is described may be deduced with the aid of the stroboscope or more simply, by applying an auxiliary voltage (time deflection) to the plate. The figure obtained now presents dark and light portions which seem to be wandering along the curve,, and the angular velocity of a given spot has the same sign as the phase difference mentioned above, provided that the number of times the curve is written per second divided by the modulating auxiliary frequency is larger than 1 or ½ or ⅓. The properties of series resonant circuits of grid and plate voltage opposition in a tube and of phase differences at different distance from a loudspeaker are readily shown.—*Hochfr. Techn. & El. Ak. 41: 53-56, 1933.*



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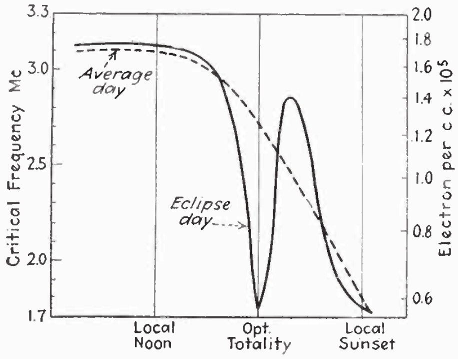
Speed regulation grid-controlled rectifiers

Direct current is used as a rule for equipment which has to run under a great variety of conditions. The direct current can be produced from a.c. and regulated at the same time by means of grid-controlled mercury arc rectifiers which are now made in glass containers for all sizes up to 200 amps. 3,000 volts. As shown by the French engineer Toulon the simplest way of varying the output is to apply an a-c voltage to the grid; if it is in phase with the plate voltage, the current passes freely; if it is in phase opposition no current passes; if the phase difference is reduced, the current can be set to have any desired value. The proper phase difference can be applied through a governor. An installation of such a rectifier with motor for hauling coal to the furnace of a power station is briefly described. Thyratrons and grid-glow tubes have also proved to be reliable for electric railways when protected against short circuits and overloading. — *Elektrot. Zeits, 54: 13, 1933.*

Solar eclipse and radio waves

NEWS OF THE BEHAVIOR OF radio waves at the time of the solar eclipse, August 31, 1932, is now making its way to the light. (See *Electronics,* August, 1932.) According to *Science* (76:444-446, 1932), tests on 2,398 kc., 3,493 kc. and 4,798 kc. (or 125 m., 86 m. and 62.5 m.) made at Deal, N. J., by Schafer and Goodall, gave minimum ionization ten minutes after the optical totality. The two shorter waves were invariably returned by the upper layer.

The method used by the Canadian expeditions (J. T. Henderson, McGill University, Canadian *Journal of Research,* 8:1-14, 1933) was to have transmitters (one near Ottawa, the other near Kingston) send signals of half a millisecond duration each. These signals reach the receiver by two distinct paths, one wave traveling along the surface of the ground, the other rising to the reflecting region and descending to the receiver placed about two miles from the transmitter. The lag of the second signal behind the first is a measure of the equivalent height to which the sky wave has traveled assuming a straight path. To measure the electron concentration (*N* per cu.cm.) the frequency of the transmitter is increased until at a certain critical value the sky signal is no longer sent back by the layer *E,* but comes from the upper or Appleton layer. $N = 0.184/10^7 f^2$. The change in *N* shown by the curves leaves no doubt that the ionizing agent producing the lower layer disappears with the shutting off of the sun's rays by the moon. Minimum ionization (60,000 electrons per cu.cm.) coincides with totality to within three minutes for the upper as well as the lower layer (as against 170,000 at noon). The frequencies used varied between 1,500 and 6,000 kc. Unfortunately, a magnetic disturbance began several days before August 31 and was still in progress during the day of the eclipse. It may explain the queer observations on 35-meter waves which Alexanderson reported in *Radio Engineering* for October, 1932, but which have little to do with the main question studied this year.



Measuring the moisture content of wheat, electrically

[H. E. HARTIG, University of Minnesota, and B. SULLIVAN, Russell-Miller Mining Co.] A parallel plate condenser, between which a thin, hard rubber cell could be inserted, was connected in one arm of a General Radio shielded capacity bridge. In the measuring arm of the bridge was connected a precision variable air condenser and an 11,000-ohm decade resistance box. In shunt with the parallel plate condenser a 100 uuf. fixed air condenser was connected for the purpose of increasing the current through the bridge and thereby the sensitivity of adjustment. To indicate balance a Western Electric four-stage vacuum-tube amplifier-voltmeter was used. Current was supplied by a vacuum tube oscillator.—*Industrial and Engineering Chemistry Anal. Edition, 5: 107-110, 1933.*

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Grid and plate currents in a grid-controlled mercury vapor tube

[A. C. SELECTZKY and S. T. SHEVKI, Case School of Applied Science, Cleveland] About 10 oscillograms are given and discussed, each showing for chosen operating points plate and grid voltage, plate and grid current of a commercial thyratron (60 cycles, 1,100 volts r.m.s. on plate, 4 amp.) The grid current lags somewhat behind the grid coltage and its direction depends not only upon the sign, but also upon the magnitude of the grid voltage. An increase of one volt in the grid potential may modify the shape of the grid current wave quite considerably. When the grid voltage is in phase with the plate voltage, the grid current curve may assume a variety of shapes depending upon the grid voltage. When the grid voltage leads the plate voltage, positive grid current flows as long as the plate is negative, and the reverse is true when the grid voltage lags the plate voltage. During this time the plate current is negative. An inverse plate current of the order of milliamperes always flows when grid current is delivered during the negative half cycle of the plate voltage.—*Journal of the Franklin Institute 215:299-326, 1933.*

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Everyday photometry with photo cells

[J. W. T. WALSH, National Physical Laboratory] The different characteristics and limitations of the three main types of photo cells, based on the external photo-electric effect (Elster-Geitel) the internal effect (selenium) and the combined photo electric and detector cell (barrier layer cell), are reviewed. The applications of the cells to the measurement of candlepower, luminous flux and illumination, the determination of polar curves, and the preparation of records of illumination are then described in some detail. For ranges of illumination below the Elster-Geitel cell must be used in combination with an amplifier.—Illuminating Engineer 26:64-72, 1933. Photo effects in semi-conductors are also described by B. Lange in a preprint (63-8 of the Electrochemical Society, p. 69 to 81).

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The Ninth French Radio Exhibition

[MICHEL ADAM.] A common feature is the use of band-pass filters in tuned receivers, either as intermediate elements or directly connected to the first tube (so-called super-inductance). In this latter case the coils are wound on glass supports so that the phase angle does not exceed half a degree as against ten times this value for ordinary coils. This leads to frequency response curves which are considered satisfactory. In superheterodyne sets band filters comprising as many as seven circuits are in use. The speaker with permanent magnets has staged a comeback, the strength of the field being increased by the use of cobalt steel. Indirectly heated cathode-tubes are much in use, and the variable mu tube has assumed the name "selectode"in France. —*Revue gen. de l'Electricité, 32: 845-851. 1932.*

◆

Transmission lines for meter-waves

[F. BAHNEMANN, University of Jena] —The telegraph equation continues to apply at these high frequencies provided that all the components of the equipment be arranged as symmetrically as possible. The potential distribution along the wires was measured directly (wavelength 2.6 m.) by means of a detector tube having two filaments in series, each facing a separate plate, the plate terminals being used to support and shift the tube. The potential produced by the rectified wave is compensated by d.c. When the generator is not symmetrically coupled to the wires, potential differences exist between opposite points and the line loses energy by radiation. With ohmic losses along the amplitude decreased about 5 per cent along copper wires 1 mm. thick and 40 m. long. For matching surge impedance and output, two parallel wires side by side are used when the load resistance is large, and two concentric wires for light loads (see in this connection *Proc. I.R.E. 20: 1163-1202. 1932.—Hochfr. u. El. Ak. 40: 189-198. 1932.*

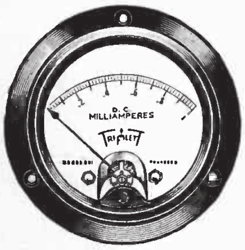
+ NEW PRODUCTS

THE MANUFACTURERS OFFER

Moving-coil instruments

The Triplett Electrical Instrument Company of Bluffton, Ohio, has just announced a new line of D'Arsonval moving-coil instruments, designed to register accurately, under severe service conditions. Two sizes of these instruments are made—in three case models. They are furnished in low-reading micro-ammeters, milli-ammeters, voltmeters up to 2,000-volts, milli-voltmeters, and ammeters.

The new instrument fits around a moulded Bakelite plate in which the terminals and assembly studs are firmly anchored. This construction combines accuracy and high insulating qualities. The metal dials are enameled permanently white with black lithographing, resulting in a most durable and attractive finish. Fine sapphire jewel bearings are used. The aluminum needle and other parts are ribbed and made unusually strong throughout. The moving coil is light in weight. The scales are extra long, uniform, and easy to read.—*Electronics, April, 1933.*



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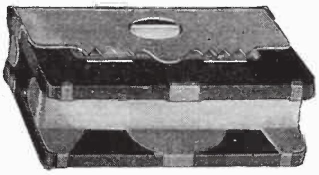
Neon lightning arrester

L. S. Brach Manufacturing Corporation, 55 Dickerson St., Newark, N. J., has developed a new neon lighting arrester for the protection of telephone, fire and police signaling, railway signaling, telegraph, radio broadcasting and other low-voltage circuits. These arresters can also be used in protection of cable wires and coil shunting, by being placed across the terminals of relays, resistors, etc.

An important feature of this type arrester is its very small and compact size ($\frac{1}{8}$ in. wide by $1\frac{1}{4}$ in. long) arranged to mount on $\frac{1}{2}$-in. centers. It will fit in standard telephone-arrester spring mountings and is interchangeable with carbon mica or carbon porcelain units.

The arrester consists essentially of a small glass tube containing two specially chemically-treated metal electrodes in neon-argon gas. The electrodes are separated approximately $\frac{3}{32}$ in. The glass tube is encased in a metal and bakelite holder so as to form a very rigid unit capable of withstanding considerable rough handling, thoroughly protecting the glass tube from injury.



Notwithstanding the wide spacing of the electrodes this arrester can be made to function at any predetermined voltage and below this operating voltage the insulation of the circuit remains constantly high. The arrester functions as a safety valve with great speed and while functioning has a very low impedance resistance.

These arresters may be easily tested either by placing across the terminal of an induction coil or placing across the spark plug of an automobile.—*Electronics, April, 1933.*

✦

A-C remote-control amplifier

The Remler Company, 2101 Bryant St., San Francisco, Calif., announces two new pieces of broadcast equipment to supplement the Remler condenser microphone. These consist of an all a-c operated remote control amplifier and microphone power supply and an a-c power supply for condenser microphones. The first is a three-stage amplifier of improved design, together with power supply. The amplifier brings the microphone output to a maximum of plus 10 decibels input into the telephone line to operate normally at a plus 2 db. level. Output is flat within plus and minus 1 decibel, over the audio range of 40 to 10,000 cycles. Equipped with level indicator and attenuator calibrated in decibels, both units are housed in a single attractive duco-finished metal cabinet 21 in. by 9 in. by 10. The weight is 40 lbs. The other device is an a-c power supply for both studio and remote installations.—*Electronics, April, 1933.*

Paper-dielectric condensers

"There is no substitute for quality" is the motto that has been adopted as the maxim of Wego Condensers, Inc., 729 Seventh Ave., New York City, for its paper dielectric condensers. Applying careful attention to minute details of design, construction and practicability, the windings are compact and non-inductive. They are impregnated in several special-process vacuum vats and the containers are small, well-insulated and light in weight yet very strong and durable. The capacity tolerance has been brought down to within five per cent plus or minus, as closely as the most advanced engineering skill will permit. The ratings are conservative and are in strict accord with recognized advanced engineering practice, and wholly borne out by the remarkably fine record of results enjoyed by all types of users everywhere—broadcast and amateur stations, airplane, short-wave and television stations, service technicians, experimenters and public address amplifier constructors, and manufacturers of radio and electrical equipment and devices.—*Electronics, April, 1933.*

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Special coils

The General Manufacturing Company, 8066 South Chicago Ave., Chicago, Ill., announces the development of an additional coil combination to be used in conjunction with the very recently developed miniature type variable condenser now being produced by the leading condenser manufacturers with special oscillator section ranging between 450 and 465 kilocycles for use in five-tube superheterodyne two-gang receivers.

Blueprints of lug positions on standard coils are available at the present time, and on request a blueprint for the five-tube superheterodyne circuit can be supplied.—*Electronics, April, 1933.*

Electrostatic voltmeters

The Sensitive Research Instrument Corporation, 4545 Bronx Boulevard, New York City, announces a new line of direct reading electrostatic voltmeters. These operate on the principle of the attraction and repulsion of electrified surfaces. The ranges obtainable run from 20 volts full scale in the type ES, reading down to 5 volts, and in the type EWC up to 40,000 volts full scale. The average scale length is 6 inches. The instruments are shielded from extraneous charges and fields are so designed that there is a minimum of danger to the operator in the high-voltage types.—*Electronics, April, 1933.*

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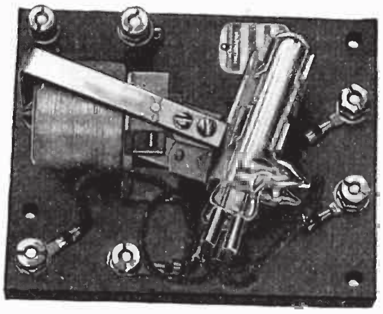
Mercury swing-type relay

Struthers Dunn, Inc., manufacturers of "Dunco" products, 139 N. Juniper St., Philadelphia, Pa., has just brought out a new type of Dunco mercury swing-type relay in which the designers have attempted, as far as possible, to move the glass around the mercury rather than the mercury in the glass. These relays have proved themselves useful in many applications where silent, sure and sparkless operation is essential. The new Struthers-Dunn P-32 sheet describes this unit, which is representative of the mercury-tube relays.—*Electronics, April, 1933.*



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Reflection meter

This new photoelectric reflection meter provides an extremely sensitive means of comparing and measuring the total reflection factors of *similar* opaque materials. The instrument is designed to illuminate an area of approximately three square inches of the material under test, and to measure on a comparative basis the total illumination reflected from this area of the material. The standard for comparison may be another similar sample, the surface of a block of magnesium carbonate, or any other desirable standard. The sample whose total reflection factor is to be measured is illuminated by a parallel beam of light normal to the surface under test. It is "viewed" by two Photronic cells placed at an angle of 30 degrees from this surface. The combined output from these Photronic cells is applied to a Weston model 440, zero-center galvanometer and balanced by the steady output of a third Photronic cell applied to the galvanometer through a slide wire bridge contained within the instrument.

The device was developed by Elmer Lyford and Monroe Barnard, of the American Photo Electric Corporation, 215 Third Ave., New York City.—*Electronics, April, 1933.*

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Core material for coils

The manufacturers of Inca coils at Ft. Wayne, Ind., have introduced a new rigid core which they have named Tru-Form, because it holds its shape and does not bulge or buckle as paper cores of the square type often do.

These new cores are manufactured under a patented process from a treated and re-inforced wood with corners perfectly mitred by special machinery.

The manufacturers who have been using these new Tru-Form coils over a period of time claim that much labor and material is saved which heretofore has been wasted, due to the difficulty of inserting the core laminations in coils where core tubes have buckled.

Information and samples may be secured from the Inca Manufacturing Division of Phelps-Dodge Copper Products Corporation, Ft. Wayne, Ind.—*Electronics, April, 1933.*

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Magnetic speaker

The new "Hyflux Trumpet" is a very powerful magnetic-type speaker which has exceptional carrying capacity for this type of horn. It is light enough to be easily handled, and therefore is adaptable to all kinds of temporary sound installations. Strong metal reinforcement at the throat and in the middle of the horn insures it against damage from rough handling. The double magnet in the unit of the Hyflux Trumpet allows it to handle a great deal of power without reducing its efficiency.

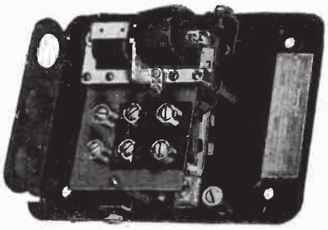
The Hyflux Trumpet unit will stand considerable power, in fact, the guarantee holds good for three watts, but one and one-half watts is recommended because it is the correct input to secure the maximum efficiency. Technically, the armature saturates at approximately one and one-half watts, therefore, any added power does not increase the sound proportionately. This small wattage makes it possible to cover a great area, by the use of a number of horns, without the necessity of a large powerful amplifier.

Finished in black weather-proof duco, the Hyflux Trumpet will stand any kind of weather. Total length—3 ft. 9½ in. Opening at bell 20 in. Weight 15 lbs., boxed for shipment. Normal operating input 1½ watts. Price, $60.—*Electronics, April, 1933.*

Mercury contact

The Mercoid Type V transformer relay meets the severe service conditions encountered with frequently operating automatic equipment, such as oil burners, stokers, air conditioners, electric heaters, traffic signals, etc. It is also adaptable for many other applications requiring a thoroughly dependable remote control.

This very simple and compact device is in principle a low voltage transformer, but also operates as a repulsion relay. It meets the demand for a positive and reliable low voltage relay by incorporating the Mercoid sealed mercury contact switch, and also by overcoming many inherent weaknesses heretofore characteristic of low voltage relay equipment.



The hermetically sealed Mercoid switch completely eliminates possibilities of open arcing, oxidation, corrosion or pitting of contacts.

As this transformer-relay does not employ the conventional clapper type iron armature, noises due to uneven, dirty or rusty armature faces cannot occur. Furthermore, there can be no residual magnetism to affect the operation as there are no metal contacting surfaces.

This relay acting as its own transformer, induces low voltage (24 volts) on the pilot circuit, thus eliminating the necessity of an externally connected low voltage transformer. It is made by the Mercoid Corporation, 4201 Belmont Ave., Chicago, Ill.—*Electronics, April, 1933.*

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Radio dials, controls and escutcheons

The Crowe Nameplate and Manufacturing Company, 1749 Grace St., Chicago, Ill., makes a complete line of direct-drive dials, tuning units, controls, nameplates, embossed escutcheons and similar radio products for equipping radio receivers. All of the tuning units have the Crowe wedge drive, except when otherwise noted. This is a smooth and powerful mechanism which gives satisfactory control. The brackets or frames in the regular output of the Crowe Company are standard for 90 per cent of the concern's production, but the company announces that it is equipped to form special bends to fit manufacturers' chasses or condensers.—*Electronics, April, 1933.*

Mobile a-c supply sources

Radio Chassis, 116 West 18th St., New York City, now offers a complete line of readily-attached automobile generators with outputs of 32 volts and 110 volts, and powers of 50, 100, 150, 200, and 300 watts. These units provide close voltage regulation and can be easily installed in the car. They are particularly adapted for sound equipment, also for aircraft radio (special wind-driven type), police radio, and emergency alternating-current supply for any standard 110-volt device. List prices range from $38.50 to $139.50.—*Electronics, April, 1933.*

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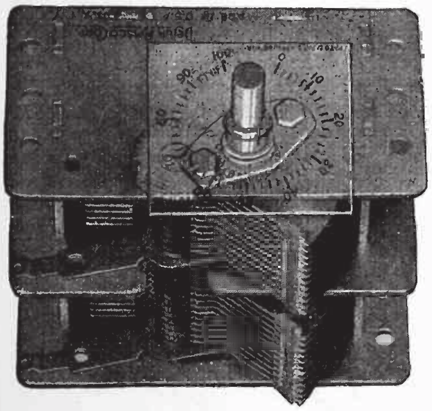
Tuning condensers and accessories

The DeJur-Amsco Corporation, 95 Morton St., New York City, has developed its midget variable condenser with special reduction drive for use on universal a.c.-d.c. radio receivers, automobile radios, and short-wave receivers. This new unit is especially applicable to superheterodyne receivers to improve tuning facility. No mechanical changes are necessary in cabinet or chassis. The knob rotates through 320 degrees. Variable condensers are also available with or without reduction drive for tuned-radio-frequency, 175 and 456 kilocycle receivers.



Other tuning accessories manufactured by the DeJur-Amsco organization include 90-degree full-vision friction-drive dials, 180-degree dials, direct-drive dials, sector-vision dials, bevel traveling drives, and dial-light sockets.—*Electronics, April, 1933.*

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Cathode-ray screen material

A New Screen Material developed by the Allen B. Du Mont Laboratories, Upper Montclair, N. J., for use on cathode-ray tubes produces a spot intensity five times as brilliant as any screen previously used. This is particularly valuable for photographic recording. A unique feature of this screen is the ability to retain for well over a minute any wave or figure applied to it when used in a darkened room or hood. This feature however in no way affects the use of the tube for ordinary oscillograph use or for photographic recording, because of the large difference between the spot intensity and the afterglow. Any of the various styles of cathode-ray tubes made by this laboratory can be supplied with this new screen at slight additional cost.—*Electronics, April, 1933.*

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Coils for small radio sets

The General Manufacturing Company, 8066 South Chicago Ave., Chicago, Ill., offers to the radio industry an entirely new winding never before provided for broadcast purposes. Such a winding has been offered for commercial long-wave use, but its adaption to the broadcast band for mass production of radio receivers is an entry into a new field of coils.

Until the present time lattice-wound coils have been the only available type of winding to meet the pressing demands for extremely small coils for the present day miniature sets, which type of winding, although answering this purpose, has not proved entirely satisfactory, in view of the extremely low gain and distributive capacity.

The new four-bank winding, although extremely small in physical dimensions, involves no sacrifice of efficiency. At 600 kc. the interstage coil, when measured in a single stage gain test with a number 58 tube, proved a gain of 110 times input, and at 1,500 kc., a gain of 65 times input. Although the above figures are given for the limits of the broadcast band only, this coil when properly balanced with any of the present standard low minimum variable condensers has an extended frequency coverage between 540 and 1,700 kc.—*Electronics, April, 1933.*

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Radio modulator

Shure Brothers Company, 337 West Madison St., Chicago, announces its new radio modulator which employs a modulated oscillator circuit.

It is thoroughly shielded and carefully designed to prevent radiation. A two-button microphone of the professional type is used, and consequently the quality of reproduction that comes out of the radio loudspeaker is comparable to the finest broadcasting stations. Some of the modern sets have such excellent tone quality and enormous reserve of power that the combination makes an ideal public-address system—and at a very low price. The list price is $33.50, complete with three tubes, microphone, and 50 ft. of cable subject to usual dealer and distributor discounts.—*Electronics, April, 1933.*

Choke coils

In high gain circuits circulating currents must be kept at a minimum. Efficient filtering requires the use of adequately designed choke coils. Such a choke coil is the Type 6A, manufactured by the General Communications Laboratories, Ridgefield Park, N. J. In the development of this choke a new method of measurement has been devised, whereby actual performance characteristics in the working frequency range are determined. The present general practice is to make such measurements at 1,000 cycles. Choke coils, for which distributed capacitance values of 3–4 *μμt* are claimed, actually measure 22–19 *μμf* respectively, at radio frequencies. The important performance index of an r-f choke coil is not the inductance but the distributed capacitance.

The r-f characteristics of the 6A choke coil are as follows:

Apparent inductance	39 mh
Real inductance	24.5 mh
Distributed capacitance	12.5 *μμt*
Fundamental anti-resonant frequency	276 kc.
D.C. resistance	145 ohms
Current carrying capacity	80 ma.
Actual suppression with 0.1 *μt* by-pass	59 db.
Working range	500—20,000 kc.

The list price of the 6A choke coil is $1.—*Electronics, April, 1933.*

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Manufacturers' bulletins and catalogues

Short-wave antennas—Installation diagrams of the Lynch antenna system. Arthur H. Lynch, 1775 Broadway, New York City.

Antenna materials—Aerial kits, arresters, shielded lead-in wire, cables, magnet wire. Belden Manufacturing Company, Chicago, Ill.

Instrument fuses—Low-range and high-speed fuses, radio fuses, high-voltage fuses. Circuit diagrams. Catalog No. 5, 1933. Littelfuse Laboratories, 1772 Wilson Ave., Chicago, Ill.

Condenser Microphones—Remote control amplifier and a.c. microphone power supply. Accessories. Remler Company, Ltd., 2101 Bryant St., San Francisco, Cal.

Resistor units—Vitrohm radio products, resistors, rheostats, magnetic relays, voltage reducers. Circular 507. Ward Leonard Electric Company, Mount Vernon, N. Y.

Microphones—Demountable models, hand microphones, etc. Ellis Electrical Laboratory, Inc., 189 West Madison St., Chicago, Ill.

Self-tapping screws—Hex-head hardened self-tapping screws for radio-set assembly. List of stock sizes. Parker-Kalon Corporation, 200 Varick St., New York City.

Rheostats—Air-cooled, water-cooled, non-inductive, precision-adjustment, high-voltage and other special rheostats. Bulletin No. 4, Central Scientific Company, 460 E. Ohio St., Chicago, Ill.

Condensers—Electrolytic units, oil-filled capacitors, by-pass condensers, paper condensers, automobile-ignition suppressors, light-socket antennas, transmitting condensers, etc. Catalog No. 123. Dubilier Condenser Corporation, 4377 Bronx Boulevard, New York City.

Photo-electric relays—Foto-switch units for commercial and experimental use. Illumination controls, counters, filters, etc. Bulletin 156-A. G-M Laboratories, Inc., 1731 Belmont Ave., Chicago, Ill.

Solder—Flux-filled solder. Gardiner acid-core solder. Gardiner Metal Company, 4820 South Campbell Ave., Chicago, Ill.

U. S. PATENTS

IN THE FIELD OF ELECTRONICS

Electronic Applications

Train control. A series of patents Nos. 1,900,403 to 1,900,412 inclusive using electron tubes for the control of trains, etc. L. O. Grondahl, assigned to the Union Switch and Signal Co.

Power circuits. A series of patents on electrical control and transmission of power from one circuit to another using electron tubes. All assigned to the G. E. Co. by various patentees. No. 1,902,462, No. 1,902,460, No. 1,901,694, No. 1,900,538, No. 1,902,495, No. 1,902,468.

Moisture measuring device. Moisture in the material to be tested changes the grid potential of an amplifier. Therefore the moisture can be measured on a plate-current meter. C. B. Limbrick, Fort William, Ontario. Filed Aug. 23, 1930. No. 1,890,545.

Measuring percentage of modulation. A modulator and an oscillator coupled by a potential transformer and a wattmeter. J. D. Wallace, Washington, D. C. Filed March 12, 1931. No. 1,884,934.

Automatic oscillograph. A method of recording both conditions leading up to a circuit disturbance and the disturbance itself consisting in temporarily magnetically storing the effect of the condition, recording a predetermined portion of the circuit condition preceding the disturbance and recording the disturbance. C. M. Hathaway, assigned to G. E. Co. Filed June 5, 1931. No. 1,883,907.

Gas-tube amplifier. Method of using a tube provided with an external control electrode, an atmosphere of gas within the tube, the relation between its geometry and the gas pressure being such that at radio frequencies amplification takes place more efficiently than audio frequencies. G. Jobst, J. Richter and W. Wehnert, Berlin, Germany. Filed Jan. 24, 1931. No. 1,889,749.

Television system. Apparatus using a Braun tube or cathode-ray tube for television purposes. August Karolus, assigned to R.C.A. Filed Nov. 30, 1928. No. 1,889,990.

Testing apparatus. Method of testing dielectric material by maintaining the material for a predetermined length of time between a potential difference of a value sufficient in that length of time to cause breakdown if the dielectric strength falls below a certain value. D. M. McBean, assigned to Beech-Nut Packing Company. Filed Nov. 7, 1930. No. 1,890,063.

Vibration recorders. Two patents to Frank Rieber, San Francisco. No. 1,902,183 and No. 1,902,184. Method of using electron tubes for measuring and recording earth vibrations, one using a piezo-electric device.

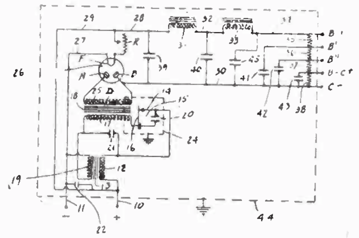
Position determination. System for controlling an electric circuit in response to a change in the position of a body with respect to a wire or other conductor connected to the grid of a vacuum tube. The circuit is a bridge system in which the grid is connected to the anode through a condenser so that the tube is normally non-conducting. Relatively small changes in the capacity of this condenser produced by change of any position of the body causes it to conduct. C. F. Whitney assigned to G. E. Co. No. 1,900,596.

Electric heating apparatus. Method of high frequency heating by means of an electrostatic field. E. P. McArthur assigned to G. E. Co. No. 1,900,573.

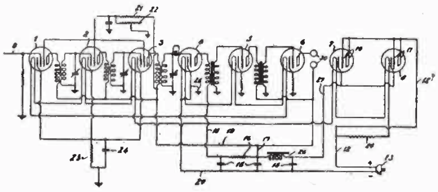
Picture transmission. Three electrode valves connected to a light sensitive cell and a means for periodically charging a condenser to interrupt the flow of current from the valve, so that the series of interruptions in the flow of current from the valve is in inverse proportion to the intensity of illumination from the cell. Otho Fulton, Bromley, England. No. 1,902,552.

Radio Circuits

D.C.-A.C. circuit. Method of using a vibrator and a transformer plus a rectifier and filter for obtaining a-c power from a d-c source. C. C. Wilson, Alexandria, Indiana. Filed April 25, 1930. No. 1,900,215.



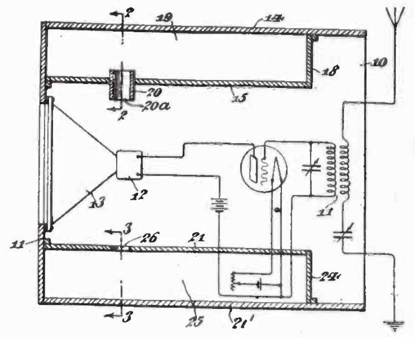
A.C.-D.C. system. Circuit in which the filaments or heaters of the tubes are connected in series and other means whereby the entire system can be energized by direct or alternating current. R. P. Wuerfel, Ann Arbor, Mich. Filed Oct. 19, 1932. No. 1,900,629.



Shield grid tube. Combination of cathode, anode, control grid and shielding means for intercepting the electrostatic lines of force extending between the electrodes. A. W. Hull assigned to G. E. Co. Filed March 3, 1924. No. 1,900,559.

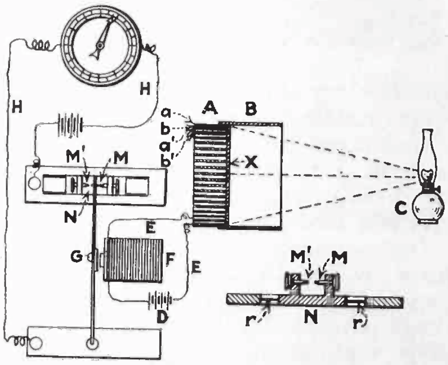
Frequency changer. Four electrode tube in which an auxiliary cathode is placed at the opposite side of the conventional cathode from the plate and nearer to this cathode than the plate. Lucien Levy, Paris, France. Filed Oct. 29, 1928. No. 1,899,622.

Elimination of cabinet resonance. During the operation of the loud speaker a relatively low pressure region is developed at a region about the diaphragm within the cabinet where a relatively high pressure region would otherwise develop. This is done by a vibratory member associated with the cabinet and means within the cabinet providing a resonator to compensate for acoustic action of the cabinet. Irving Wolff assigned to R.C.A. Filed April 18, 1930. No. 1,901,388.



Piezo-crystal receiver. Method of eliminating the heterodyne note resulting from interference between two signals of closely adjacent frequencies comprising selecting from the received signal energy, the energy which is mainly of the frequency of one of said signals; separating a relatively small amount of the total received signal energy and combining said small amount of energy in phase opposition with the said selected signal energy. James Robinson, assigned to British Radiostat Corp. Filed June 9, 1930. No. 1,898,895.

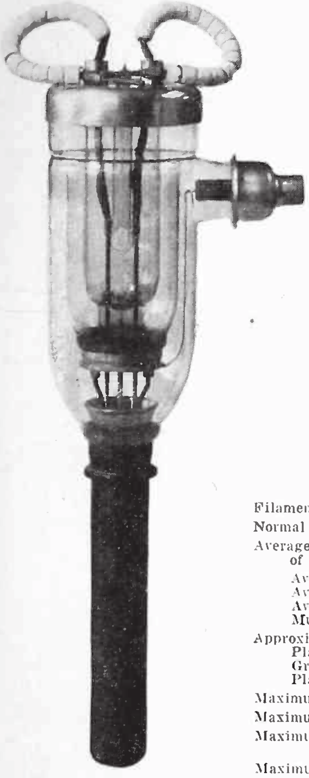
Light-Sensitive Counter—1885



Through the courtesy of Mr. Samuel Wein the above circuit is reproduced from the patent papers of C. W. Weiss. It indicates a source of light, a light-sensitive surface (selenium) operating a relay and a counter. The patent was applied for in 1884 and granted June 10, 1885. The patent claims, "the method of actuating a registering device which consists in causing each person or object passing a given point to intercept rays of light falling upon a selenium surface included in an electric circuit whereby another circuit is closed and a registering device therein actuated."

Federal Telegraph Company

offers to tube users



F-307-A 20 KW

Typical Water Cooled Tube

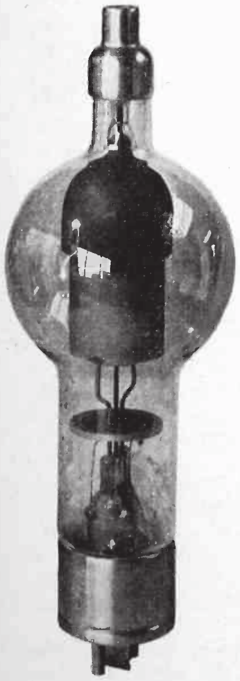
Exclusive Constructional Featrues

Sturdy Tripod grid support combining unique heat dissipation features.

Tipless stem insuring perfect alignment of internal elements. Rugged grid seal exclusive in Federal tubes making them capable of carrying higher radio frequency grid currents than most other tubes on the market.

CHARACTERISTICS

Filament Voltage	22 Volts
Normal Filament Current	52 Amperes
Average Characteristics with Plate Voltage of 7,000 volts and zero grid bias:—	
Average Plate Current	1.9 Amperes
Average Plate Resistance	3,500 Ohms
Average Amplification Factor	20
Mutual Conductance	5700 Micromhos
Approximate Direct Interelectrode Capacities:	
Plate to Grid	27 Mmf.
Grid to Filament	18 Mmf.
Plate to Filament	2 Mmf.
Maximum Operating Plate Voltage	15,000 Volts
Maximum Plate Current	2 Amperes
Maximum Continuous Plate Dissipation,	10,000 Watts
Maximum Overall Length	20¼ inches
Maximum Diameter	4 3/16 inches



F-369-A

Typical Mercury Vapor Rectifier

Latest Constructional Features

Complete shielding of arc discharge:—

- Giving higher arc back voltages.
- Decreasing effective bulb blacking.
- Diminishing effect of radio frequency fields.

Special cathode construction insuring the permanency of the oxide coated filament and consequent longer life.

CHARACTERISTICS

Filament Potential	5 Volts
Filament Current	20 Amperes
Approximate anode cathode potential drop when conducting	15 Volts
Maximum Peak Plate Current	5 Amperes
Maximum Peak Inverse Potential	20,000 Volts
Maximum Overall Length	14⅜ inches
Maximum Diameter	5 3/16 inches

A Research and Manufacturing Organization — Federal Telegraph Company experience in Radio dates back to the early Poulsen Arc era. It maintains an engineering staff associated with Dr. Frederick Kolster. Its specific tube manufacturing experience includes tubes of such wide varieties as are used by telegraph, telephone and wireless communication companies.

A Line of Standard Tubes — Federal Transmitting Tubes are built for service and proven by years of successful operation in exacting communication services, such as point-to-point and ship transmitters. Federal tubes include oscillators and amplifiers at all frequencies and all rectifier types and sizes. Rigid manufacturing and testing requirements insure tubes of uniform quality and long life. Ideal for radio and industrial uses. *Federal offers equal or greater efficiency in terms of better performance and life per unit cost.*

A Special Tube Manufacturing Service — Because of extensive research facilities, Federal is able to undertake the design and manufacture of any special tubes as may be required in radio or industrial applications. The development of the 18 cm. ultra-high frequency oscillator is typical. Problems in providing tube types such as amplifiers, measurement devices, etc., are especially in Federal's scope. CONSULT US ON YOUR SPECIAL TUBE PROBLEMS.

Engineering Data on Standard Radio and Industrial Tubes on request.

FEDERAL TELEGRAPH COMPANY

200 Mt. Pleasant Avenue
Newark, N. J.

BRITISH PATENTS

IN THE FIELD OF ELECTRONICS

Electron Tube Applications

Temperature control. Automatic control system comprising a temperature responsive device and a galvanometer operated thereby, controlling the exposure of a photoelectric cell to a source of light, the current traversing the cell being applied to the grid circuit of a grid-controlled rectifier which controls a heating circuit. H. R. Kelly, British Thomson-Houston Co., No. 372,007.

FIG.1.

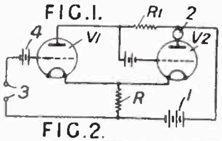
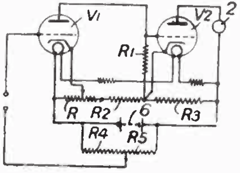


FIG.2.



Automatic volume control. By means of rectified voltage derived from a "double diode" rectifier which may be a standard triode in which the cathode and grid act as one pair of rectifying electrodes for the modulation frequency, while the cathode and anode act as a second pair of rectifying electrodes, automatic gain control is secured. P. O. Farnham, assigned to Marconi Company, No. 381,847.

Automatic tone control. To prevent undue background noise in an automatic volume control radio receiver the higher audio-frequency signals are by-passed when the received signal is weak or absent. W. S. Barden, Marconi Company, No. 381,868.

Superregenerative receiver. Quenching or pendulum frequency is obtained from a relaxation or spill-over oscillation circuit which includes a glow discharge lamp. Telefunken, No. 381,902.

Audio compensation. Signals are arranged to produce shock excitation of a resonant circuit in order to re-introduce overtones which have been deliberately suppressed at the transmitter by passing them through a tube biased to produce considerable distortion. Telefunken, No. 382,020.

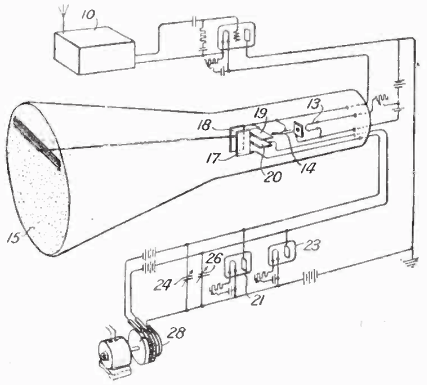
Oscillator circuit. In a superheterodyne the received frequency is supplied directly to the grid of an oscillator-detector and is prevented from neutralizing itself across the grid circuit or leaking away from the grid to the cathode by inserting one or more elements of high a-c resistance or an oscillatory circuit tuned to the received signal. O. Wullenweber, Denmark, No. 382,057.

Electron-coupled oscillator. Circuit in which the oscillations occur between the control grid and a second grid, a third grid being used to shield the output or plate circuit from the electrodes which generate the oscillation. Such a circuit is inherently stable with respect to variations in the impedance of the load circuit. J. B. Dow, Wired Radio, Inc., No. 382,316.

Inverter circuits. In a parallel type inverter comprising tubes fed from a d-c circuit and supplying a.c. to a transformer, a time delay is introduced between the closing of the switch and the commencement of discharge in either of the tubes by means of a resistor-condenser combination connected to the grid circuit of the tubes. International G. E. Company, No. 381,910.

Time delay circuits. Circuits for limiting the anode current of a tube for a period after switching on of cathode current comprising a gas discharge tube, a condenser, a resistor and an electromagnetic relay. G. E. Company, Ltd., No. 382,434.

Television. Beam of cathode rays traverses a fluorescent screen by charged electrodes. A system designed to cooperate with a transmitter employing a rotating scanning disc. R. D. Kell, British Thompson-Houston Co. No. 366,477.



Automatic volume control. Use of two valves having different operating characteristics, so that for weak signals one valve has little effect, while for strong signals it opposes the amplifying action of the other valve to give practically constant output. L. L. Kramolin, Berlin. No. 375,273.

Frequency stabilizer. The frequency of the generator is stabilized by producing unreflected waves in a mechanical oscillator from the output energy, transforming these waves back into electrical oscillation and feeding the latter to the input circuit of the generator. C. W. Hansell, assigned to Marconi Co. No. 375,568.

Superregenerator. Periodic quenching is secured by rhythmically varying the capacity of the condenser in a tuned circuit by means of a separate oscillator. Siemens & Halske, Berlin. No. 375,620.

Television system. The combined telephone and two-way television system. R. D. Parker, assigned to E.R.P.I. No. 375,785.

Navigation control. To facilitate the navigation of aircraft or other vessels advantage is taken of the characteristic periodicity of the local electric light supply to enable the nevigator to distinguish between the diffused light above a town and beacon lights or other sources of modulated devices from an airport or landing field. Two cells are used connected to push-pull amplifiers through condensers which pass only the a.c. component due to the electric light, as distinct from the steady content of natural light in the sky. The amplifier is connected to vibrating reeds, one tuned to the normal frequency of the electric light supply and the other to a special modulation from the beacon or signal light at the aerodrome. In a modified arrangement a single cell is arranged in the tail of the aircraft and is illuminated successively from alternate sides by means of a revolving mirror driven by a wind turbine. Code messages may be sent to the pilot and infra red or ultra violet lights may be used instead of visible lights. I. Langmuir, British Thomson-Houston Co., No. 371,824.

Electron Tubes

Cathode construction. A wire or tip of gold silver, a metal of the platinum group or an alloy thereof coated with an oxide or hydroxide of an alkaline earth, rare earth, or earth metal by passage through a highly concentrated solution of a suitable compound where it is treated by electrolysis with such a high current density that sparking or firing effects are produced, the purpose being to anneal to the surface of the conductor the deposit as it is formed. The foundation wire or strip may be of a base metal such as tungsten or a chromium-nickel-iron alloy coated with a thin layer of one of the specified precious metals. The electrolyzing current may be periodically broken to provide uncoated lengths of wire or strips in alternation with coated lengths. L. Hansbirg, Carinthia, Austria, No. 381,964.

Cathode construction. A heater of refractory metal wire of diameter less than 0.06 mm. arranged in zigzag formation with two or more sections and surrounded by a solid coherent insulation which is inclosed by a tubular cathode spaced slightly from the insulation over at least a greater portion of its length. The heater operates on 50 volts as a minimum. The clearance between cathode and insulation may be less than 0.5 mm. For economic current consumption the ratio of heater surface and cathode surface should be at least 0.35. For example an insulator had a diameter of 1.8 mm. and length 30 mm. The cathode is spaced 0.5 mm. from the insulator and has a thickness of 0.1 mm. The heater is a tungsten filament of 0.023 mm. in diameter and 1,900 mm. long, wound into a helix and arranged in the cathode in four parallel sections. The heater operates from 110 volts. B. Erber, Vienna, No. 382,230.

Grid construction. Prevention of secondary emission from the grid by a coating of tantalum oxide. E. A. Giard, Igranic Electric Co., Ltd. No. 382,605.

electronics

radio, sound, communications and industrial applications
of electron tubes • • • design, engineering, manufacture

Binaural reception

◆

Synchronous broadcasting

◆

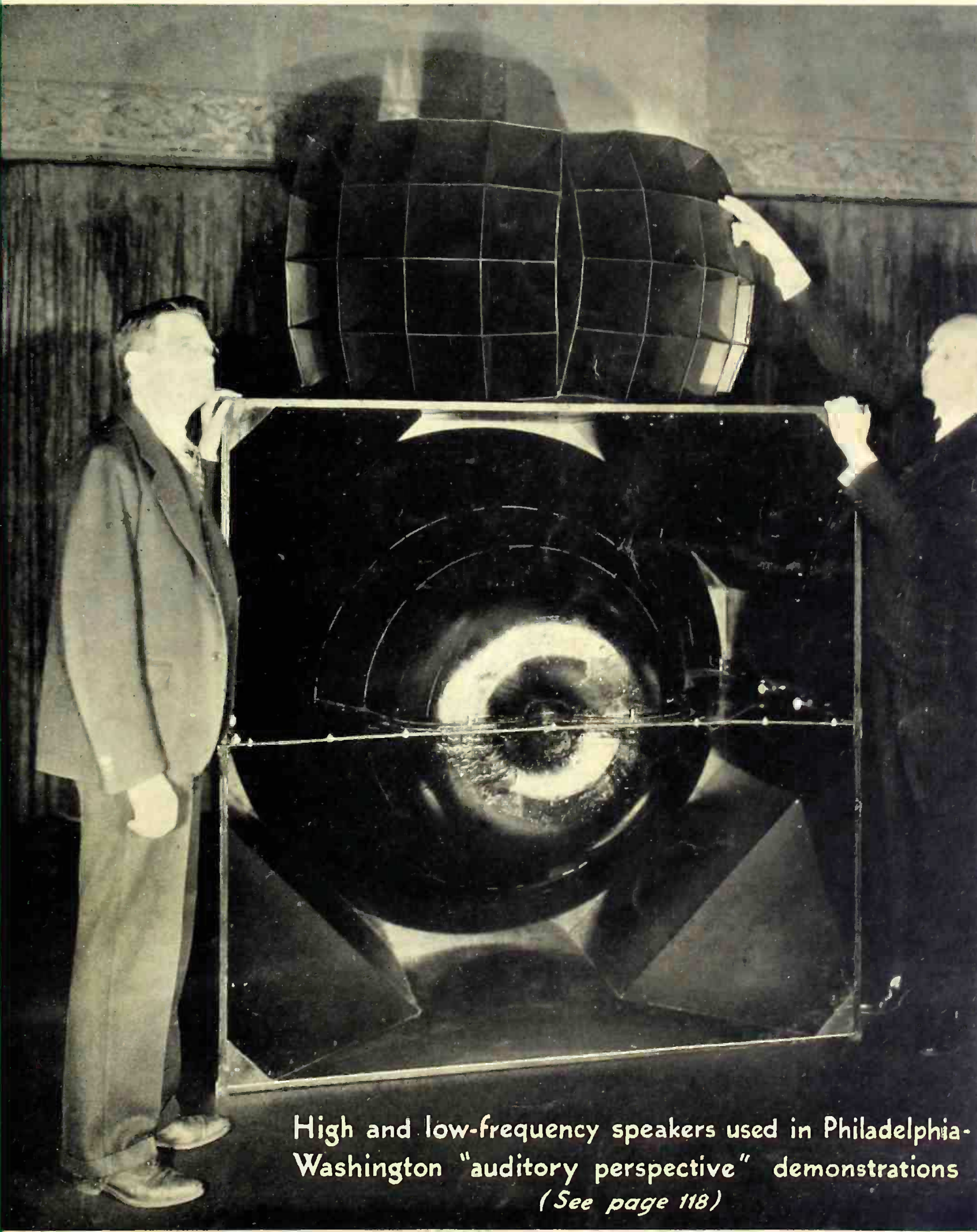
Electronic control in a tube plant

◆

Photoelectric color matchers

◆

"Speech radios" versus "music radios"

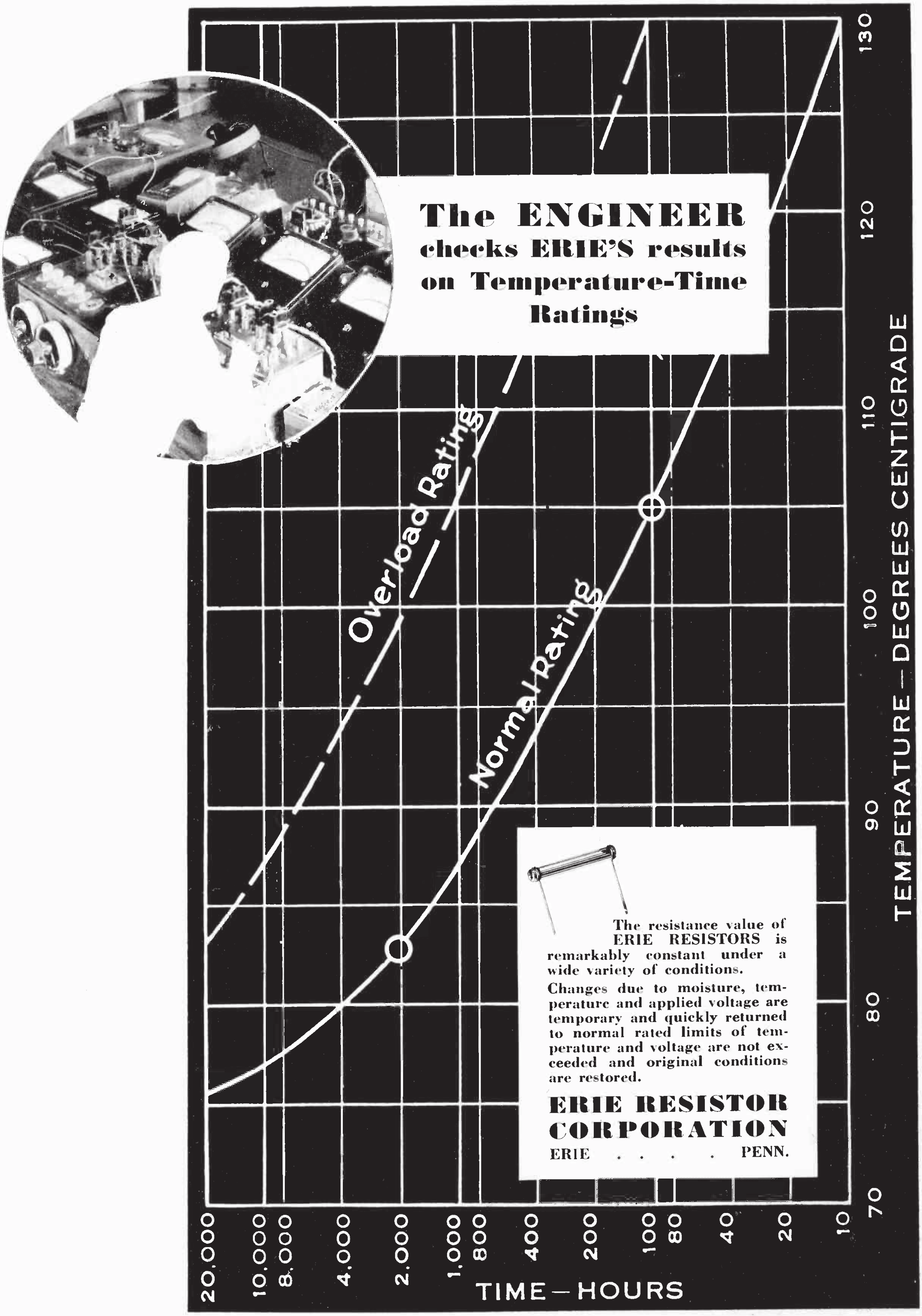


High and low-frequency speakers used in Philadelphia-Washington "auditory perspective" demonstrations
(See page 118)

McGRAW-HILL PUBLISHING COMPANY, INC.

Price 35 Cents

MAY, 1933



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The resistance value of ERIE RESISTORS is remarkably constant under a wide variety of conditions.

Changes due to moisture, temperature and applied voltage are temporary and quickly returned to normal rated limits of temperature and voltage are not exceeded and original conditions are restored.

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Electronics, May, 1933. Vol. 6. No. 4. Published monthly. McGraw-Hill Publishing Company, Inc., 330 West 42d Street, New York, N. Y. $3.00 per year, 35 cents a copy. Foreign Postage, $4 U. S. Currency or 20 shillings. Canada (including Canadian duty), $3.50. Entered as second-class matter April 4, 1930, at the Post Office at New York, N. Y., under the Act of March 3, 1879.

electronics

O. H. CALDWELL
Editor
KEITH HENNEY
Associate Editor

McGRAW-HILL PUBLISHING COMPANY, INC.

Vol. 6, No. 5. New York, May, 1933

radio
sound pictures
telephony
broadcasting
telegraphy
counting
grading
carrier systems
beam transmission
photo cells
facsimile
electric recording
amplifiers
phonographs
measurements
receivers
therapeutics
traffic control
musical instruments
machine control
television
metering
analysis
aviation
metallurgy
beacons
compasses
automatic processing
crime detection
geophysics

▼

Big Radios— Little Radios

Tell the public the difference!

THE public is now being offered radio sets at prices all the way from $12 to $400. Is it any wonder that the man or woman ready to buy a set, stands confused by this wide range of prices? The advertisements call them all "radio sets," and there has been little to make clear to the public the wide difference in the service they deliver. Let's make the difference clear.

The little "pee-wees," the cigar-box models, the midgets, the personal radio sets, all bring in voice, speeches, news, etc., distinctly and understandably, even if (as in a telephone) the full tones are missing. So let's classify that whole group of little sets as "speech radios." And let's enthusiastically sell and recommend these little sets—these "speech radios" for use where voice and speech are chiefly to be received.

BUT if the customer wants to listen to music—to the great singers, to the great symphonies, to jazz orchestras, or to a brass band—then there is no question that he needs a *musical instrument*, a *musical reproducer*—a "*music radio.*" Every living-room, every home, needs a "music radio" to bring the great music that is on the air, and which the broadcasters have spent so much to transmit with complete fidelity.

If radio manufacturers who make a full-line covering both classes—if radio dealers who sell the full range—will set up this classification and distinction in their minds, in their advertising, their selling, their sales presentation, and their demonstrations, the public will soon become relatively conscious of "speech" radios and "music" radios.

"SPEECH radios," personal radios, will then go ahead to widening usefulness. On the other hand, the market for quality receivers—"music radios,"—will be preserved, for the future of musical enjoyment in the American home.

TRANSMIT "AUDITORY

Three-channel Philadelphia-Washington circuit creates striking illusion of reality in placement

"AUDITORY perspective" by which the sounds of the instruments in a great orchestra seemed to come from different sides of an empty stage, exactly as if the orchestra itself were seated on that stage, instead of being in another city 150 miles away, was the striking feature of the Bell Laboratories transmission of Dr. Stokowski's Philadelphia orchestra to the audience of the National Academy of Sciences, meeting in Washington, April 27.

In addition, new extensions of the frequency band were transmitted, including tones from 40 cycles to 16,000 cycles per second, affording new degrees of utter realism, in the reproduction of wind instruments, bells, snare-drums and other effects.

Tremendous augmentation of the orchestra's own full volume, even to intensities as high as ten times the volume of the orchestra itself, was also demonstrated, with Dr. Stokowski himself at the controls in the receiving auditorium at Washington, thus introducing a new factor in emotional and musical response to whispering pianissimi and thunderous crescendos.

"Stereoscopic hearing"

With such equipment, explained Dr. Frank B. Jewett, president of the Bell Telphone Laboratories, a musical director may produce at one or more distant points a completely faithful replica of the tonal effects produced locally in the auditorium in which his orchestra is performing. Auditory perspective, which increases the reality of the effect, much as the stereoscope improves a flat panorama, is also available to give a complete illusion of the actual presence of the orchestra at the distant points.

The new system differs from those hitherto familiar, not only in its greatly increased range of tone and loudness compared with the average sound-picture installation (40 to 45 decibels), but in its use of three separate transmission channels. Beginning at microphones in the city of origin of the music, suspended at right, center and left of the orchestra, each channel passes through its own amplifiers and telephone line to a loud speaker similarly placed on the stage of the auditorium in the distant city where the music is received. How this arrangement enables the distant audience to sense the location of instruments on the stage was explained by Dr. Jewett from its approximation to a sound-proof curtain containing a number of holes. Were the number great this set-up would approach that of a gauze curtain which, if let down between the audience and the orchestra, would not interfere with their usual sense of perspective. As the holes, in imagination, coalesce into three large openings it is not hard to believe that the sense of position will persist. Actual tests have amply confirmed the theory.

Fidelity and volume range

To emphasize the importance of tonal range Dr. Jewett discussed the sounds produced by orchestral instruments. From the bass viol with its lowest note at 40 cycles per second, to the snare drum, violin and oboe whose highest overtones reach 16,000, is a range of eight and a half octaves. Were the lower end of this range cut off, the music would sound thin and "tinny," while the upper end contributes the crispness and brilliance that is necessary for complete illusion.

Of equal importance to an orchestral leader is the ability to deliver an ample volume of sound; in fact the largest orchestra (70 decibels) is occasionally inadequate for climactic effects. The electrical system therefore was designed for a sound output up to 80 decibels,—ten times as great as that of a full orchestra. The pianissimo passages of a violin are about one-hundred-millionth as loud, and since they must not be marred by noise picked up during transmission, a rigorous requirement for quietness was placed on the electrical system. So well has this been met by engineers of Bell Telphone Laboratories that during silent intervals the sound output of the loud spakers is only one three-hundredth of that heard by a motion-picture audience during the silent moments of the best films.

Starting with the dynamic microphones hung a short distance in front of the stage in the American Academy

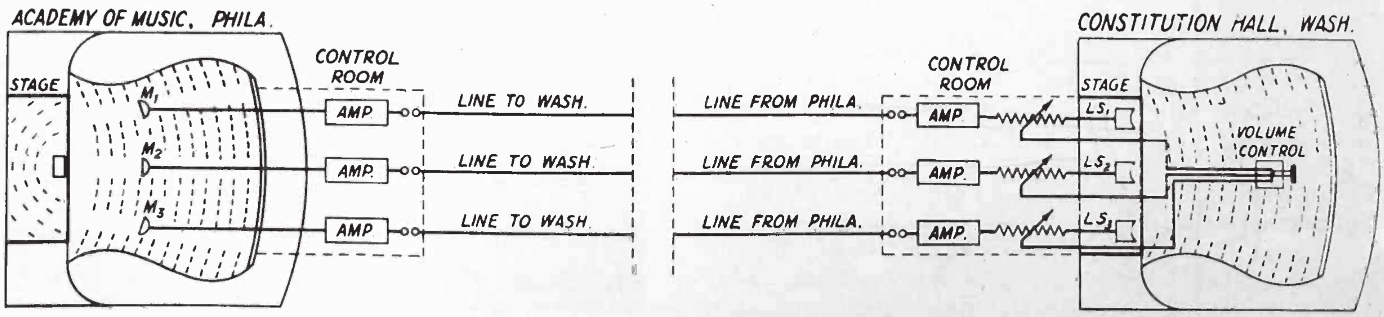


Diagram showing arrangement of the three microphones in Philadelphia, amplifiers, telephone channels, and Washington amplifiers and loudspeakers on stage of Constitution Hall

PERSPECTIVE" IN MUSIC

Bell Laboratories cooperate with Dr. Stokowski's orchestra in 16,000-cycle fidelity at ten-fold volume

Dr. Frank B. Jewett and Dr. Harvey Fletcher of the Bell Laboratories with one of the low-frequency speaker diaphragms

of Music in Philadelphia, from which the music was transmitted, Dr. Jewett described the amplifiers in that building. Particularly important are the method and the equipment used for long-distance transmission by wire to Washington. The carrier-current method was used, and transmission was by underground cable throughout. Intermediate amplifiers were located at five points en route. To raise the output of the microphones to the level required for the loud speakers, and to make up for line losses, a total amplification of a million million million million (10^{24}) times was required.

Providing the large sound output for the heavy low notes, one loudspeaker unit of enormous size was used on each channel, and two smaller ones were used to radiate the higher notes. Each of the high-frequency speakers has a 16-cell 60-degree diffuser, to distribute the sound output over a greater angle, (see front cover), giving a total of 120 degrees. The combination has an output capacity of 80 watts for the higher range and 200 watts for the lower. E. C. Wente and A. L. Thuras of the Bell Laboratories are shown in the front-cover picture.

In contrast to the practice in broadcasting and phonograph recording this system places no restrictions on an orchestra or its leader. Volume controls are available to the director who sits with the audience at the receiving point, but these are used to secure certain tonal effects rather than to "compress" the volume to a range which can be transmitted and handled by receiving sets.

Acknowledging indebtedness to Dr. Leopold Stokowski, director of the Philadelphia Orchestra, Dr. Jewett said:

"During the course of investigations carried on in Bell Telephone Laboratories, we had developed telephonic systems of high quality, but for further researches we needed opportunity to utilize music in its most perfect forms. Now it happened that Dr. Stokowski was interested in the possibilities of electrical systems for the production of exceptional orchestral effects. Through his voluntary cooperation, therefore, the Laboratories' scientists were able to make quantitative physical studies of music as rendered by his orchestra, and so to perfect their designs; and with the completion of the new equipment some of the possibilities which Dr. Stokowski had hoped for have become practicable."

Experiments demonstrate sound placement

The remarkable "auditory perspective" or sense of location of individual sound sources on the empty stage, was strikingly demonstrated by several other experiments performed over the three-channel transmission. These experiments actually originated in Philadelphia, but were observed by the audience at Washington, and were interpreted there by Dr. Harvey Fletcher.

On the stage of the Academy of Music at Philadelphia, where the pickup microphones were installed, a workman busily constructing a box with hammer and saw was heard receiving suggestions and comments from a

Dr. Leopold Stokowski, director of the Philadelphia Orchestra, at one of the Washington amplifiers

fellow workman in the right wing. All the speech and accompanying sounds were transmitted over cable circuits to the loud speakers on the stage of Constitution Hall in Washington. So realistic was the effect that to the audience the act seemed to be taking place on the stage before them. Not only were the sounds of sawing, hammering and talking faithfully reproduced, but the correct auditory perspective enabled the listeners to place each sound in its proper position, and to follow the movements of the actors by their footsteps and voices.

For another demonstration, the audience heard a soprano sing "Coming Through the Rye" as she walked back and forth through an imaginary rye field on the stage in Philadelphia. Here again her voice was reproduced in Washington with such exact auditory perspective that the singer appeared to be strolling on the stage of Constitution Hall.

An experiment which demonstrated both the complete fidelity of reproduction and the effect of auditory perspective was performed by two trumpet players. One, in Philadelphia at the left of the stage of the Academy of Music, and the other in Washington at the right of the stage of Constitution Hall but invisible to the audience, alternately played a few phrases of the same selection. To those in the audience there seemed to be a trumpet player at each side of the stage before them. It was not until after the stage was lighted that they realized that only one of the trumpet players was there in person. The music of the other was transmitted from Philadelphia with such perfect fidelity and reproduced in such true perspective that it was impossible to tell one of the players was absent.

The auditory perspective effect is not restricted to placing sounds in their correct positions across the stage, but is three dimensional. This was shown by having several sources of sound (such as sleigh-bells) moved around the stage in Philadelphia, not only back and forth but high up in the center of the stage as well. The movement of each sound was faithfully reproduced by the speakers high above the level of the stage floor.

Dr. Stokowski pictures the possibilities

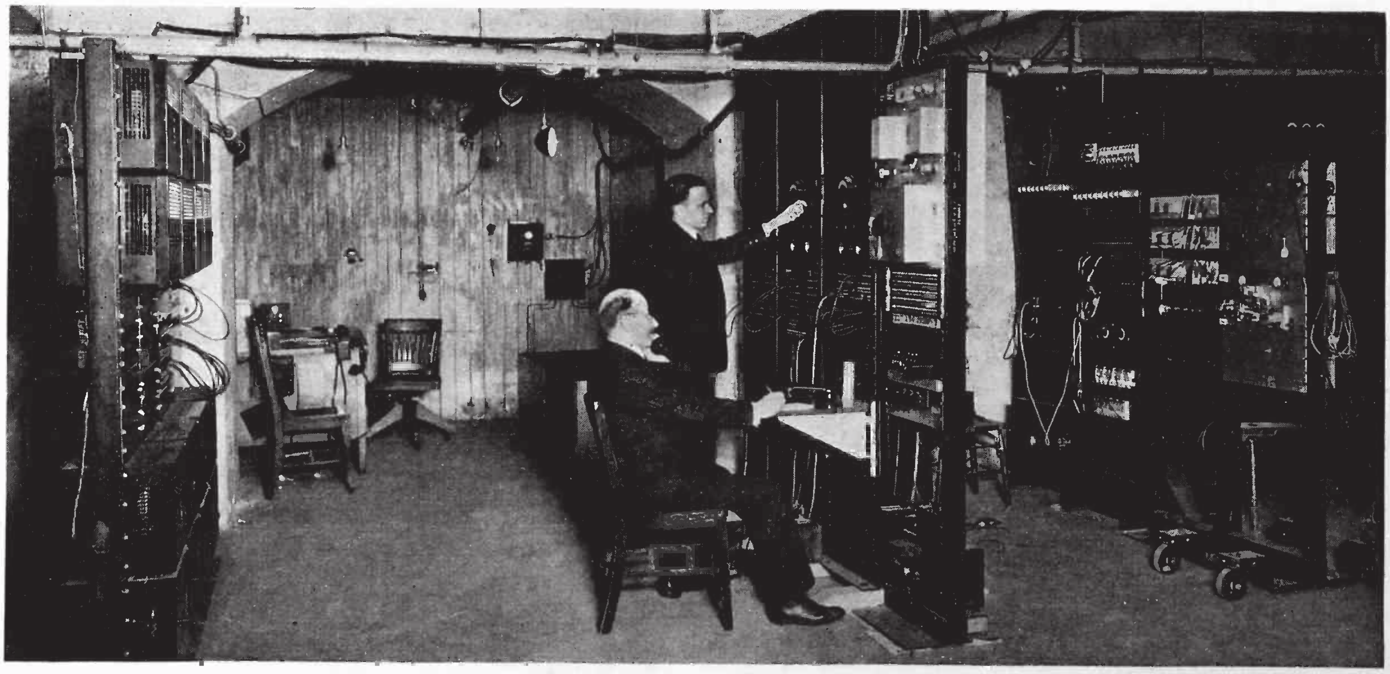
In commenting on the transmission of music and its future opportunities, Dr. Stokowski said:

"One element in all scientific progress is its application to our life. Here, in my opinion, this new method of conveying sound to many other places over great distances without distortion or electrical disturbance or static—is of national importance. For example there are symphony orchestras in only about ten or fifteen cities in the United States and there are thousands of other cities or towns with no orchestra. At the same time the cities which have the orchestras are at the present time finding it difficult to support them.

"By this method, cities like Cleveland, or Detroit or Chicago, for example, which have fine symphony orchestras, could send out to all the neighboring towns and cities within a generous radius, the symphonic music they create, so that in all these towns and cities music lovers can hear the music exactly as in the original. This will enable the city having the orchestra to enlarge its public and improve its orchestra in quality, and will enable other cities which have at present no orchestras, to create them and send out their music to neighboring towns and cities without distortion or any lowering of quality.

"By this means we could zone the whole country and have a first class symphonic orchestra in the most important city of each zone, thus giving variety to our music—more opportunity to the generation of American musicians now growing up—more opportunity for the American composer to have his work heard—more opportunity to the new generation of American conductors—and more opportunity to the music lover to hear many types of music variously played, and by comparison of these different methods, less standardization and more individuality.

"By all these means wired transmission can enrich our musical life—reaching the most remote parts of the North American continent."



The control room and transmitting amplifiers in the basement of the Philadelphia Academy of Music. During the demonstration, the Philadelphia orchestra played on the stage of this building, while Dr. Stokowski sat with the Washington audience and manipulated the volume levels there

The role of vacuum-tubes in a tube factory

By W. P. KOECHEL

The Ken-Rad Corporation

VACUUM tubes are finding an increasing use in all branches of industry. It is not strange, therefore, that they also find wide use in a tube factory where electronic circuits of some sort or another enter into almost every operation. It may be of interest to describe some of the applications to which electronic circuits are put in the Ken-Rad plant. Although only the more recent applications will be described, a list is included of various others. Some of them have been previously described, some are common knowledge and others are new. Electronic tubes play the major role in each of the following circuits or devices: supervision of all factory d-c voltage lines (*Electronics,* December, 1932, page 418); temperature control of electric coating ovens (*Electronics,* May, 1932, page 170); automatic cathode-heating time indicator (*Electronics,* September, 1932, page 293); delayed time circuit on life test rack to delay application of plate voltage until after tube cathodes have heated; voltmeters for measuring peak voltages and currents; oscillators for bombarders; amplifiers for leak detectors, noise tests, wave form analysis, impedance bridges, etc.; rectifiers in a.c.-d.c. circuits for supplying test voltages; Pirani gage alarm indicator for change of air pressure of 1 micron; mutual conductance measuring (described here); timing circuit for controlling time of spray application of cathode coating (described here); meter protective circuit for sensitive meters (described here), and automatic control of output of d-c generators.

Measuring low values of Gm

When amplifier tubes are operated under cut-off conditions, Gm is often as low as 1 micromho, and therefore difficult to measure by either bridge or direct reading meter methods. The following circuit, however, permits of accurate measurements down to 1 micromho.

Fundamentally the principle of measuring Gm. involves the measurement of small changes of plate current caused by small changes in grid voltage. By definition this becomes $Gm = \frac{i_p}{e_g}$. These changes in grid voltages may be either d.c. or a.c. If a.c., they will cause an a.c. component of current to be present in the d.c. plate current of the tube.

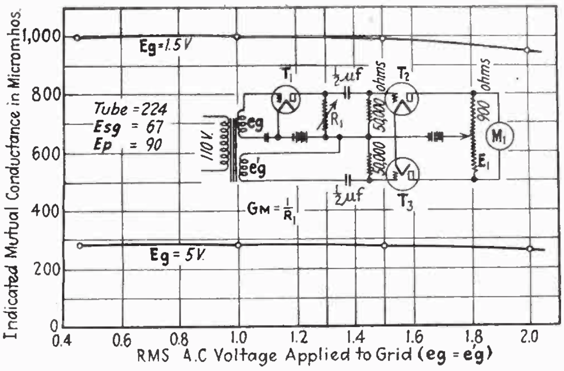


Fig. 1—Circuit of Gm-meter and measurements made on screen-grid tube

It is important in actual measuring circuits to use not more than 1 volt for the applied grid increment or signal. A larger value than this causes harmonics in the a.c. component of the plate current and appreciable error in indicated Gm. Therefore, we are limited to a voltage value of not more than 1 volt for e_g (even less for some types of tubes). If this value of grid voltage is applied to a tube with a Gm of 1,000, there will be exactly 1 ma. change or 1 ma. a.c. component in the plate circuit of the tube. This amount is comparatively easy to detect in a number of ways, including the dynamic meter method and bridge method. However, when we get to lower values of Gm. (such as required under cut-out conditions), the corresponding plate current change for a 1-volt grid change is extremely small. For instance, for a Gm. of 1 micromho we would have only 1 μ amp. change, or 1 μ amp. a.c. component in the plate circuit. There are at present no suitable meters available for measuring a.c. currents of such small orders. Any scheme for accurately measuring low values of Gm will, therefore, necessarily involve using amplification.

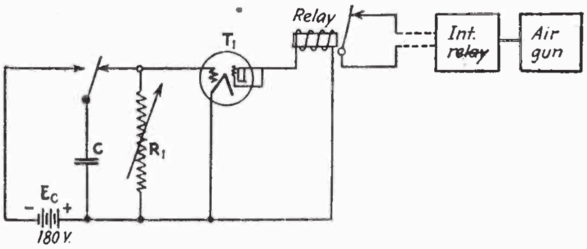


Fig. 2—Circuit for automatically controlling cathode spray gun

If it were possible to use a distortionless amplifier with an overall *current* amplification of 100 connected ahead of a direct-reading Gm meter, we would have the required sensitivity, but this would necessitate having an accurately calibrated amplifier, such that the overall amplification was at all times maintained at exactly 100. At present this is not practical.

The circuit to be described makes use of amplification, but uses two tubes in such a way that all variables of plate voltage and applied signal voltage are cancelled out and do not affect the final reading. Figure 1 shows the circuit. R_1 is calibrated directly; T_2 and T_3 represent tubes matched with respect to impedance and plate current (UY-237). The voltages e_g and e_g' are equal. This can be accomplished either by using a center-tap resistor, or two separate windings of equal value.

With an a.c. signal e_g applied to the grid of tube T_1, the following relations obtain

$i_p = e_g\ Gm.$ If R_1 is adjusted so that $e_p = e_g' = i_pR_1$

$e_p = i_p R_1$ Then $\text{Gm} = \frac{i_p}{e_g} = \frac{i_p}{i_pR_1} = \frac{1}{R_1}$

Thus it will be seen that regardless of the values of e_g (providing $e_g = e_g'$) Gm will be given by $1/R_1$. If desired e_g' can be made to equal $e_g/10$, in which case the indicated reading on the calibrated dial of R_1 must be divided by 10. This will permit using a lower value of R_1 with a consequent lower error correction.

The equalizing of the voltages e_g and e_g' is accomplished by using a push-pull amplifier, as shown. The microammeter M will indicate any difference in plate current between the two tubes T_2 and T_3, caused by applications of unequal voltage values to the two grids. With potentiometer E_1 properly adjusted and no a.c. signal applied to either grid, the microammeter will show zero reading. This zero reading will not be affected if a.c. signals of equal amplitude (and equal phase) are applied to each grid. Therefore, the only indication which will show up on the meter is the difference in plate current between the two tubes caused by signals of ***unequal amplitude*** being applied to the grids of T_2 and T_3. When R_1 is adjusted so that the voltage across it is equal to e_g', there will be signals of equal amplitude applied to the grids of tubes T_2 and T_3 and give a zero reading on the microammeter. Under these conditions, readings on the calibrated dial of R_1 give a direct indication of Gm.

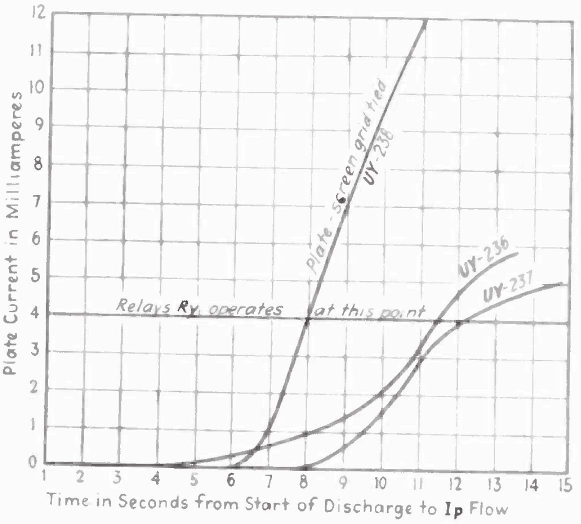


Fig. 3—Sharp cut-off of 238 compared to other tubes for use in spray-gun circuit

Variations of amplifier plate voltage will not affect the balance point of R_1, for an increase will give an equal increase of current on both tubes and therefore no indication on M. Furthermore, the potentiometer E_1 is always balanced initially to give a zero setting on M. The amount of plate voltage on the amplifier tubes does, however, affect the sensitivity of the amplifier. The greater this plate voltage the greater the sensitivity and response of the amplifier.

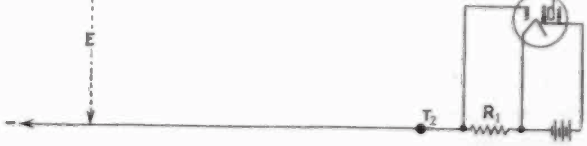


Fig. 4—Protective circuit for sensitive meter—using vacuum tube

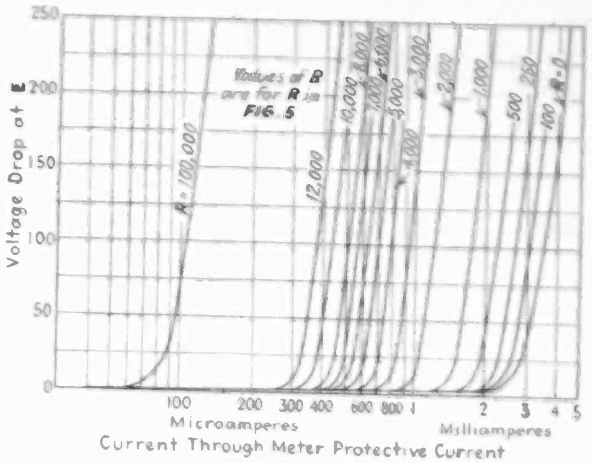


Fig. 5—Current flowing through protective circuit as function of resistance and input voltage

In balancing for a reading, the resistor R_1 is varied until the meter indicates null reading. In other words, the amplifier is always balanced for the final reading by a 1-volt a.c. signal to each grid. If the value of e_g should change any, e_g' will change by an equal amount and the balance will, therefore, be obtained at exactly the same point on R_1. The results of varying e_g and e_g' simultaneously are shown. It will be noted that the indicated value of Gm did not change appreciably until the signal voltage on the grid exceeded 1.6 volts.

As R_1 is in the plate circuit of the tube, there will be a slight IR drop across it, due to the d.c. plate current through it. For an extremely accurate reading this can be compensated by increasing the plate voltage to give normal plate current reading.

In addition to the inappreciable error caused by the d.c. drop across R_1 there will be a small error caused by the presence of external impedance in the plate circuit.

As indicated, Gm is equal to $\mu/(R_p+R_1)$ it follows that if R_1 is low enough, the error due to it can be neglected. In measuring tubes under cut-off condition, R_1 is by comparison with r_p extremely small, and, therefore, its effect in the circuit will be negligible.

Furtherfore, by making $e_g' = e_g/10$, R_1 will be 0.1, the value it would be for $e_g = e_g'$.

The accuracy of indicated mutual conductance when read by the foregoing method will depend entirely on the accuracy of the calibrated resistor R_1. As the calibrated dial attached to resistor R_1 is merely turned until the meter indicates null, this circuit is almost as fast as a direct-reading meter.

Tube controlled cathode coating

To further improve uniformity of quality of cathode-type tubes it is necessary to have complete control of the application of the cathode coating. Too heavy or too light a coating will each have detrimental effects on the final characteristics of the completed tube. As this coating is applied to the cathode sleeve by means of an air gun, the coating weight will be partially dependent upon the length of time for which the gun is operated. If this time is dependent on an operator's judgment, considerable lack of uniformity will be in evidence. However, by utilizing an automatic timer operating an electric air valve, this human element of error is eliminated.

An automatic timer developed for this purpose makes it possible to pre-set for any required time between 2 and 20 seconds, as specifications may dictate. If, for instance, the timing dials are set for 7.5 seconds and the starting button is pushed, the spray gun will operate for exactly 7.5 seconds and at the end of that time be automatically shut off.

This device involves no clock work or moving parts and can be made up to operate with an accuracy of 1 per cent. The timing unit is completely assembled into a small cabinet having on the outside two dials calibrated in time values. One dial is calibrated from 2 to 20 seconds in 1-second steps, the other from 0 to 1 second in continuously variable steps. A red and green pilot light are mounted on the panel for monitoring purposes. A push button provides the means for starting the timing circuit. The air supply to the gun is controlled by an electrically operated air valve, which is actuated by the timing circuit. After the cathodes to be sprayed have been placed on a revolving head (in line of fire of the spray gun) the starting button is pushed which starts the timing circuit and actuates the air valve for the proper length of time according to the setting of the dials.

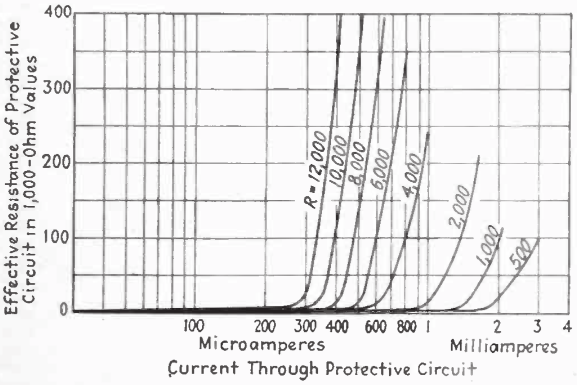


Fig. 6—Effective resistance of protective circuit

The basis of the timing circuit is the *time of discharge of a condenser through a resistor*. The condenser and grid leak are connected across the grid of a tube (see Fig. 2), so that when the condenser is charged a bias voltage will be applied to the grid, which gradually decreases as the condenser discharges through the grid leak. The time of discharge will be entirely dependent on resistor and condenser values and on the value of applied charging voltage. By using a calibrated variable resistor R it is possible to obtain any time value within the range of the resistor. As timing depends only on the values of R, C and E_c, the accuracy of time values will be governed by the quality and constancy of the resistors and condensers used.

The relay in the plate circuit operates only when one volt or less bias is applied to the grid. Therefore, if the condenser C is charged to 180 volts, it must "leak off" or decrease to one volt before the relay can operate. The time consumed for this discharge from 180 to 1 volt comprises the time element of the circuit.

The tube used for the amplifier is a 238, because the characteristics of this tube permit a very sharp I_p pick up when the bias voltage reaches a low value. The use of this tube, as compared to several others, is illustrated by the curves shown in Fig. 3. With the 38, the actual possible error due to non-uniformity of relay operation is minimized.

This timing circuit has been in use for many months and still retains its initial calibration accuracy and has also found application in many other operations (See *Electronics*, April, 1933, page 105). It makes an ideal method for operating the light source of an automatic printer in connection with photographic work. It is also very suitable for use in connection with grid stretching equipment where the time of heating the wires being stretched is very important.

Protecting meters by vacuum tubes

In using sensitive meters, such as d.c. microammeters and galvanometers, there is always the possibility of damaging the meters, due to accidental application of high voltage. Common methods of protecting meters are to have either a series resistor or fuses, or both in the circuit. However, a series resistor with a resistance value high enough to protect against maximum possible voltage would decrease the sensitivity of the meter and require a switching arrangement to short out the resistor for actual measurement. In tube-testing work the gas meter is in that portion of the circuit where if any tube elements are shorted there is applied the full plate voltage across the terminals of a microammeter.

The ideal protection for any low-range microammeter or milliammeter would be a resistor which at any current within the range of the meter being protected would have zero resistance. With any current flowing in excess of the range of the meter, this resistance should go to infinity. With such a resistor in series with any low range meter it would be impossible to damage it even with the direct high voltage applied.

A protective circuit has been developed which very closely approaches the ideal. It utilizes a vacuum tube, a resistor and a source of low voltage. When the terminals T_1 and T_2 of Fig. 4 are inserted in series with any suitable current meter, it becomes in effect a resistor having characteristics, as shown by curves in Figs. 5 and 6. That is, at low current ranges the voltage drop across it is extremely low (as is also the effective resistance). However, at any current value beyond the knee of the curve bend, the voltage drop rapidly rises. The upper end of each of the curves shown represents the condition which would exist in protective meter circuits if 250 volts were applied directly to the current meter with this circuit in series. It is this same condition that exists in factory test sets when a shorted tube is accidentally inserted in the test socket.

By suitable selection of resistor R_1 and screen-grid voltage values, it is possible to design this circuit to have a sharp cut-off at any current value desired and to correspond to the range of the meter to be protected. For instance, if a 0-300 microammeter is to be protected, R_1 should be made 12,000 ohms. Under these conditions the circuit will have a low resistance as long as not more than 300 microamps flows. However, if there should be an accidental short at X, the most current that would flow will be 460 ma., assuming a voltage of 250 at E.

This protective circuit has been in use on test equipment in this factory for over six months, and during that time not one single meter has been damaged. It is, of course, applicable to any other circuit where protection is desired for low range d.c. instruments.

Due to limited space, only the most pertinent data has been given in this article, and complete technical analysis of each circuit was purposely omitted for the same reason. Furthermore, the list of items reviewed by no means represents the entire field of use of vacuum tubes in this plant, but merely the more important ones.

Time delay effects in synchronous broadcasting

By CHARLES B. AIKEN
Bell Telephone Laboratories

IT has been very generally observed that reception is usually bad in the middle zone between two synchronized broadcasting stations, where the field strengths are of the same order of magnitude. Theoretical studies have shown that the quality of reception in such areas is dependent, to a much greater extent than has been formerly realized, upon the difference in total time of travel of the program over the two complete paths from the studio microphone to the receiving antenna. It has been shown[1] that the quality of reception will be the same as that from one station alone, provided that the two times of travel are identical, the modulations of the two carrier waves are the same, and the total low frequency phase shifts in the two paths are the same. But if the times of travel differ by only a few dozen microseconds serious distortion may result. In most cases such time differences are exceeded and reception is spoiled, but theory shows that this is not unavoidable. Relative time delay plays an important rôle, and there is given below an account of an experimental investigation of its effects.

When the waves from two stations which transmit on exactly the same frequency, and which radiate the same program, impinge upon the receiving antenna, they may be regarded as combining vectorially into a single wave of complex form. In making studies of the detection of such a wave, the phase relations between analogous components of the waves from the two stations must be carefully taken into account. Assume, for the moment, that the receiving antenna is located midway between the two transmitters, so that the waves travel over paths of equal lengths in the ether. If the stations are modulated with a single frequency $\frac{P}{2\pi}$, the two waves may be represented by:

$$E\,[1 + M \cos Pt] \cos \omega t$$

and

$$e\,[1 + m \cos (Pt + \beta_0)] \cos (\omega t + \gamma_0) \qquad (1)$$

E is the amplitude of the stronger carrier and e the amplitude of the weaker, M and m are the respective degrees of modulation, $\frac{\omega}{2\pi}$ is the frequency of both carriers, γ_0 is the phase angle between the carriers at the receiving point, β_0 is the phase angle which would exist between the envelopes of the two waves if γ_0 were zero.

▼

THE possibilities existent in a broadcasting system with numerous stations operating on the same frequency and with the same modulation make most important Mr. Aiken's laboratory determination of the resulting distortion at a receiving point. It is hoped that as a result of this experimental investigation a more efficient disposal of the existing channels may ultimately be made.

▲

Now, if the receiving point is moved so that it is d_1 meters from the first station and d_2 meters from the second, new values must be assigned to the phase angles in accordance with the following expressions:

$$\gamma = \gamma_0 = \frac{\omega D}{C} \qquad (2)$$

$$\beta = \beta_0 - \frac{PD}{C} \qquad (3)$$

where $D = d_2 - d_1$ and $C = 3 \times 10^8$ meters per second, the velocity of propagation.

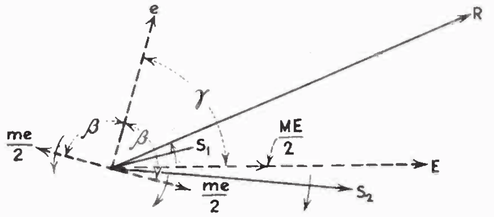


Fig. 1—Vector diagram of two waves of the same frequency and same modulation

The two waves impressed upon the receiver at this point may then be represented, in a very general manner, by

$$E\,[1 + M \cos Pt] \cos \omega t$$

and

$$e\,[1 + m \cos (Pt + \beta)] \cos (\omega t + \gamma). \qquad (4)$$

The significance of γ and β may be shown graphically by a vector diagram representing two modulated waves. In Fig. 1, E represents the carrier of the stronger signal, e that of the weaker, γ the angle between them at time $t=0$; that is, when the vectors representing the two side frequencies of the stronger wave are coincident with their carrier. At this instant each side vector of the weaker wave makes an angle with its carrier which is equal to β. R is the resultant carrier and S_1 and S_2 are the resultant side frequencies. From the inequality in the sizes of these side frequencies and their lack of symmetry with respect to their carrier, it is evident that the detection of this combination of waves will yield dis-

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[1] A more extensive discussion of the subject matter of this paper, and of related problems, will appear elsewhere.

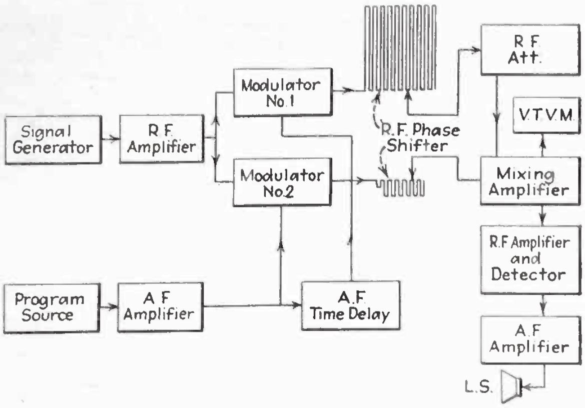


Fig. 2—Block diagram of laboratory set-up for determining effects in isochronous broadcasting

tortion products of considerable magnitude.

β is dependent upon what happens in the a-f circuits between the studio and the modulators of the transmitters, as well as upon path differences in the ether. In general, β will have a different value for each audio frequency present in the modulating program. If, for example, there is a constant difference in time of transmission of the two programs, β will be smaller for the low frequencies than for the higher. As this type of delay is of common occurrence, we may study its effect of time delay to great advantage. Furthermore, time delay due to difference in path length in the ether will affect β the same as will delay in the audio circuits.

Before proceeding to the experimental study of the effect of time delay, we shall establish an important proposition. If in (4) $M=m$ and $\beta=0$, then the sum of the two received waves reduces to:

$$E\sqrt{1 + 2K \cos\gamma + K^2}\,(1 + M \cos Pt) \cos(\omega t + \epsilon) \qquad (5)$$

Where $K = e/E$ and ϵ is a function of γ only.

Now this is an ordinary modulated wave of amplitude $E\sqrt{1 + 2K \cos\gamma + K^2}$ and of degree of modulation M, and hence the distortion upon its rectification will be the same as that in the detection of any wave (of the same degree of modulation) which might be received from a single station. It is evident that if, in a given region, the value of β could be kept small for all of the frequencies present in the modulation spectrum, high quality reception would be possible even when the field strengths of the two received waves were nearly equal, and this would be true regardless of the phase angle between the carriers. Further, if β could be made to have a value identically zero for all of the modulating frequencies, then the quality of the rectified signal would not be impaired for any value of the field strength ratio, except insofar as noise background might appear when the resultant amplitude was very small.

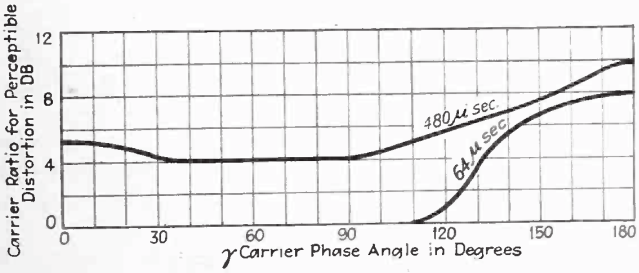


Fig. 3—Carrier ratio to cause perceptible distortion to appear in a linear detector

Since relative time delay will have the same effect whether it occurs in the audio or radio circuits, or the ether paths, it may be introduced at any one of these places which is most convenient. In the present work the audio circuit was chosen as being most readily manageable, and means were provided for introducing variable amounts of time delay between the program source and one of the modulators of two otherwise identical laboratory transmitters.

A block schematic of the circuits used is shown in Fig. 2. The outputs of the modulators were fed through an r-f phase adjusting device to a mixing amplifier. The phase shifter consisted of variable lengths of high frequency cable giving a phase shift of 0.80° per foot at 1100 kc., the frequency at which the work was done. A calibrated attenuator was included in one output, to adjust the relative level in steps of 0.1 db.

The mixing amplifier consisted of two shield-grid tubes having a common plate circuit impedance. Across this impedance was connected a tube voltmeter. By cutting off one voltage supply, the carrier amplifier of the other could be measured, and the process then reversed. In making measurements the carriers were first adjusted to equality at the terminals of the voltmeter. Any desired ratio could then be obtained by the attenuator.

A suitable portion of the output of the mixing amplifier could be fed to either of two radio receivers, one equipped with a square law and the other with a linear detector. Both had fidelity characteristics which were essentially flat to 5000 cycles, and both were carefully tuned to the carrier frequency. All observations were made on a frequency of 1100 kc., and the peak modulation of both transmitters was held at about 80 per cent.

Check of distortionless case

As the first observational step, a check was made on the validity of the theorem that when $M=m$ and $\beta=0$ there is no distortion but only variations in intensity of the resultant signal as K or γ are varied. To this end, the r-f output from a single modulator was divided into two parts which were fed to the two phase adjusting circuits of Fig. 2. The two signals thus derived were adjusted to equal amplitude and to various carrier phase relations. The output of the mixer amplifier was monitored on the receiver with the linear rectifier.

No difference in quality could be noted between the resultant signal and one signal alone. When phase opposition was nearly obtained, so that the resultant carrier was 44.7 db below either carrier alone, no distortion could be detected, although the background noise was unpleasant. This was due to the high noise field in the vicinity. A change in the carrier ratio of 0.1 db was sufficient to bring the resultant signal above the noise.

Determination of tolerable carrier ratio

A time delay of 480 microseconds was introduced into the program feed circuit of one modulator. There was then determined the carrier ratio at which the distortion was slightly, but definitely, perceptible. Tests were made in the open laboratory where listening conditions were about average. The distortion noted would hardly be perceptible to the average observer, although entirely appreciable to the engineer. A higher standard of quality could have been employed, but it is felt that the results obtained would have been of less value in their application to the problems of isochronous broadcasting.

The upper curve of Fig. 3 represents the average of a number of observations, and indicates the carrier ratio, as a function of γ, at which perceptible distortion sets in when a linear detector is employed and the program consists of speech, with peak modulations running about 80 per cent. Programs were derived from two sources, a phonograph record and a high quality microphone with a 5000 cycle low pass filter in the amplifier circuit.

The character of the distortion observed near $\gamma=180$ degrees was very different from that noted when γ was near 0 degrees. With approximate phase opposition, a value of K less than that indicated by the curve resulted in non-linear distortion of an extremely unpleasant type. When K=0 db and $\gamma=180°$ the resulting uproar was frightful. On the other hand, when γ was near zero the distortion showed chiefly as a reduction in fidelity, certain frequencies being badly attenuated. This was to be expected, since, with a delay of 480 microseconds, and with K=0 db, the frequency of 1013 cycles should vanish and the band of frequencies in the vicinity of 1031 cycles should suffer badly. However, impairment of fidelity is not nearly so unpleasant as non-linear distortion. Even when K=0 db the quality for γ near zero might be considered as being very nearly within the usable range, if a rather low standard of quality is assumed.

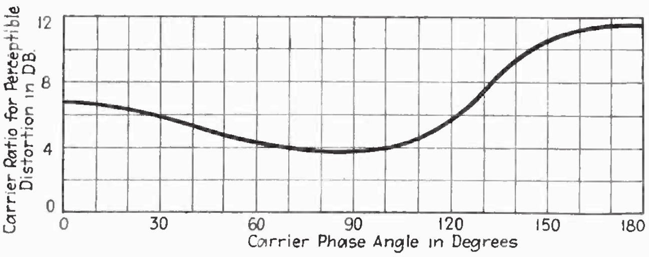


Fig. 4—Data similar to that of Fig. 3 except taken on a square-law detector

The point of perceptible distortion is much less sharply defined when the question is one of fidelity than when it is one of non-linear distortion, and the relation between the standards of judgment employed in the two cases must necessarily be rather indefinite. Consequently, the left hand portions of the upper curve of Fig. 3, and the curve of Fig. 4 (square low detector), cannot be considered as being as definitely established as are the right hand portions of these curves.

The quality of the performance of a square law detector is appreciably inferior to that of the linear detector when only a single modulated wave is received. Judgments based on a perception of additional distortions, due to the presence of a second wave, yield curves which are hardly different for the two types of rectifiers. However, the absolute magnitude of the distortion products are greater, on the average, for the quadratic type.

The lower curve of Fig. 3 is for a relative time delay of 64 microseconds. Appreciable distortion occurs only when γ is greater than 120° and the maximum carrier ratio required is less than when larger delay is used.

Figure 5 shows a curve of the carrier ratio which yields perceptible distortion when the time delay is varied, γ being maintained within ± 1° of 180°. The data were taken with a linear rectifier. With a relative delay of 200 microseconds the carrier ratio necessary to eliminate distortion is practically as great as that required for larger delays.

A field strength ratio of 2:1 will permit of a relative delay of about 50 microseconds. If a larger delay occurs, there will be distortion when the carriers are near phase opposition.

The foregoing work was done with speech programs but additional work was carried out with musical programs. Observation on several types of music showed that a ratio of 11 to 12 db was necessary to reduce the distortion to a very small value. Hence a ratio that protects speech from distortion under the worst conditions will also be about right for music.

A number of interesting conclusions may be drawn from the experimental results obtained. These conclusions are in agreement with the theoretical work which has been done and from which many of them have already been predicted. They may be listed as follows:

Distortion is most serious, both in magnitude and in type, when $\gamma=180°$, i.e. when the carriers are in phase opposition.

When γ is near 180° the distortion is of a very unpleasant non-linear character, while when γ is near 0° the distortion is largely a matter of impaired fidelity and is not nearly as unpleasant.

When the time delay is zero and the circuits of the two transmissions are identical to a high order (i.e., when B=0 for all of the frequencies present in the modulation spectrum and M=m) there is no distortion when a linear rectifier is used, while with a square law rectifier the distortion is the same as that which appears in the rectification of a single wave of the same modulation.

The advantage, from a standpoint of quality, which is to be gained by using a linear rectifier, instead of a square law rectifier, is about the same as that realized when only one transmission is received. The carrier ratio at which additional distortion becomes perceptible as the weaker wave is increased in amplitude is about the same for either type of detector, although the absolute quality of the output of the linear device is better.

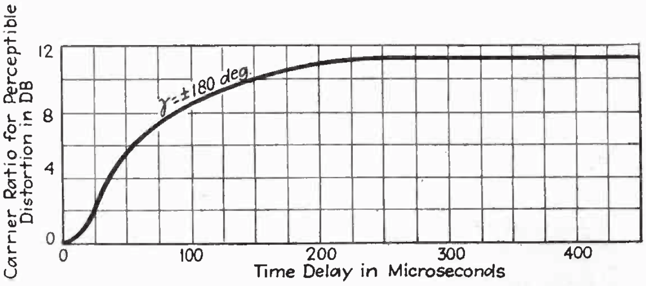


Fig. 5—Effect of time delay in producing distortion in isochronous broadcasting

A carrier ratio of about 12 db is sufficient to reduce distortion to a just perceptible amount, even under the worst practical conditions, provided the stations are not guilty of over-modulation.

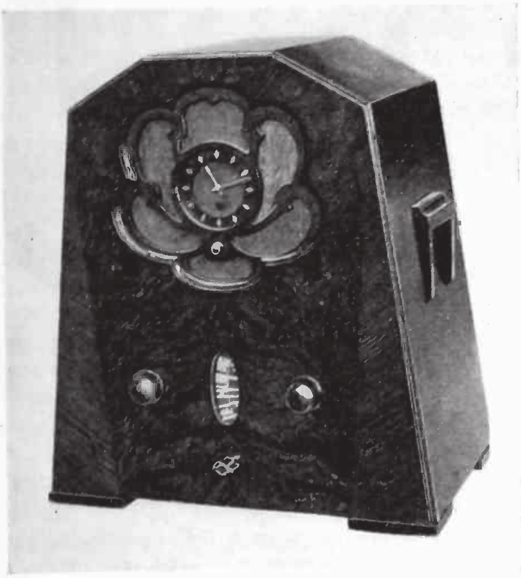
What may be regarded as very small time delays are capable of producing serious distortion in an otherwise ideal system. This is due to a disturbance of desirable phase relations and not to anything in the nature of echo effects. Delays hundreds of times as large are required to produce the latter.

A relative time delay of 200 microseconds will be responsible for distortions which are essentially as serious as those produced by those much larger.

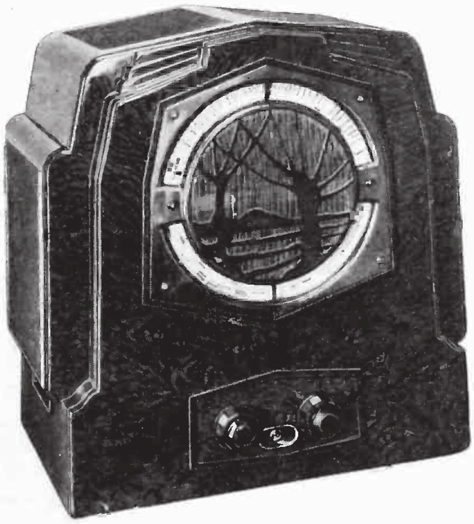
A relative delay of only 50 microseconds between two otherwise identical transmissions will produce a distortion, when the carriers are out of phase, which is of sufficient magnitude to require a carrier ratio of about 6 db for its elimination. Fifty microseconds corresponds to a difference in path length in the ether of only 9.3 miles.

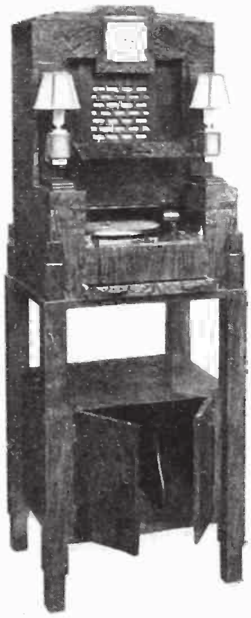
New designs in British radio receivers

British radio manufacturers have been leading the way in redesigning their receiver cabinets along radical new lines. While the designs shown are perhaps not particularly recommended for use on this side of the Atlantic, American designers who have seen these photographs declare them to be distinctly better than average American radio designs



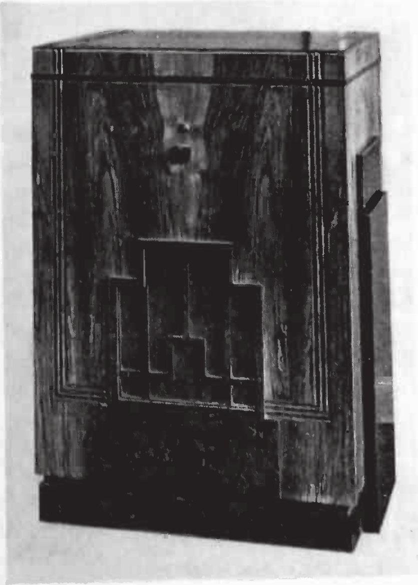
The clock-combination idea seems to interest British listeners as well as Americans. A clock is essential to listening in for special programs, and the clock is useful when the radio is turned off

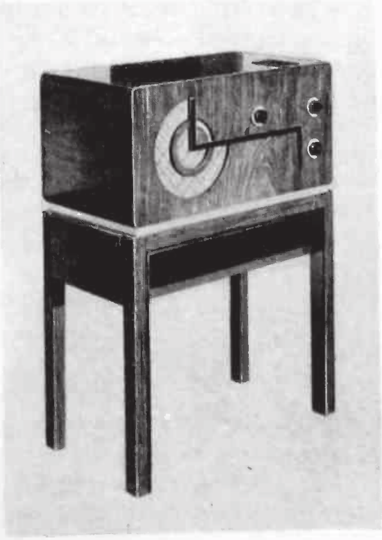


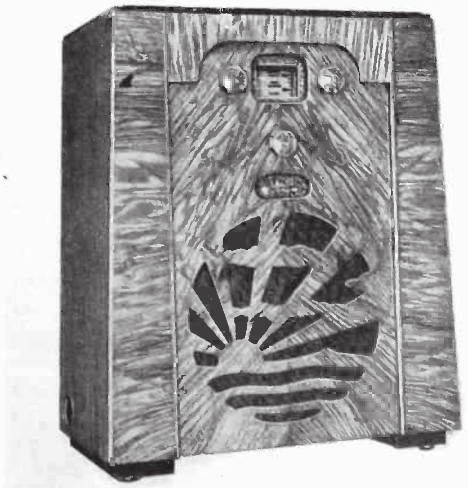


A combination phonograph-radio-clock unit

The novelty dial above surrounds the loudspeaker, and is provided with a pointer for accurate station tuning





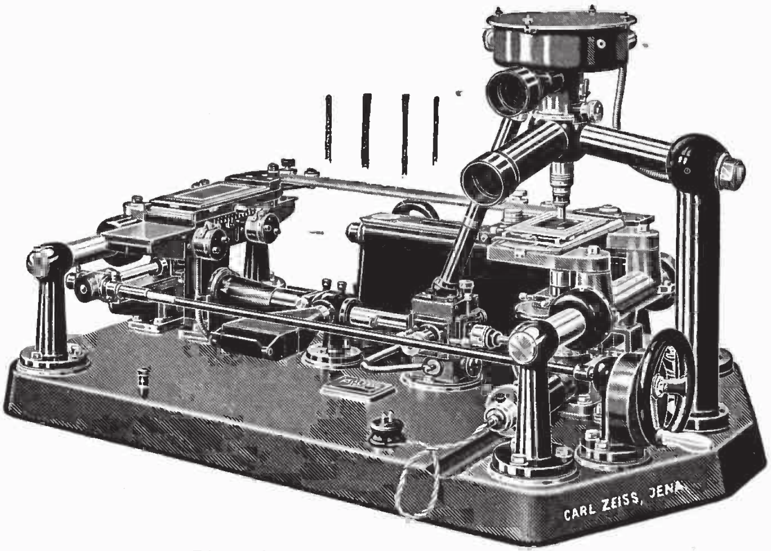


The new European art principles are apparent in these receivers occupying the lower half of the page. But already these motifs have penetrated America in other articles

English and Continental designers go in for square and straight-line effects to a greater extent than American radio manufacturers have yet used

Photoelectric color measuring instruments

By HERBERT NEUSTADT, Jr.



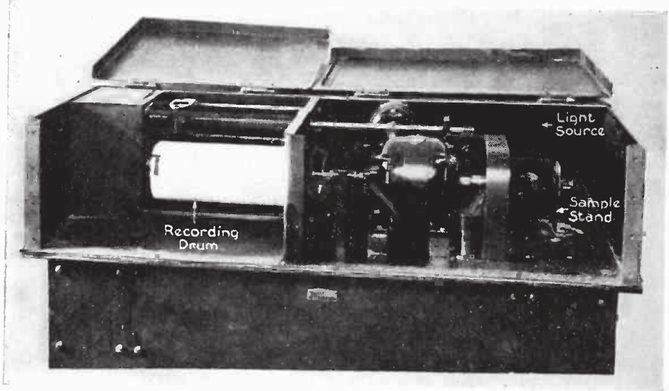
Photoelectric recording photometer of Carl Zeiss, for recording density of photographic film

PHOTOELECTRIC methods of color measurement have the advantages of: (1) speed of observations, (2) lack of eye fatigue, (3) no necessity of a trained observer, (4) full sensitivity at end regions of visible spectrum, (5) no necessity of darkening room during observations. These advantages are combined with the fact that a well designed photoelectric instrument is as accurate as any other type instrument, or more so. The instruments classified below are: color analyzers, which give a spectral energy distribution curve; color comparators, which determine whether a visual color match exists between two samples; one-variable instruments, which measure or match a single optical property of a sample.

Color analyzers

Color analyzers give complete information about the color of a sample because they produce a curve of reflection or transmission coefficients versus wavelength. These curves constitute a mathematical, unchanging definition of a color and can therefore be used to great advantage in cataloging, specifying, and mixing dyes, paints, inks, etc.

For example: the General Electric photoelectric recording color analyzer, automatically plots a continuous color curve on a liquid or solid sample for the visible range, 4000-7000 Å, in about 3½ minutes. It is accurate enough to check with Bureau of Standards data on a color filter and is constant enough to retrace a curve on a sample without appreciable widening of the pen line. It represents a modification of an instrument first developed by A. C. Hardy[1] and may be described as follows. When used to obtain a reflection curve, one half of a collimated beam of monochromatic light is intercepted by a right prism and sent to the sample. The light reflected from the sample then goes to a flicker disc. The other half-beam, not intercepted by the right prism, goes to the flicker disc through a shutter. This flicker disc has its solid sectors coated with a standard white pigment and is so situated with respect to a photocell that, as it revolves, the cell alternately receives one beam reflected from the sample through the open sectors of the wheel, and then receives the other reflected from the standard white solid sectors. The alternations occur 60 times per second. If the two beams differ in intensity, the cell output will be a 60-cycle pulsating current. The a-c component of this output is applied through an amplifier to the field coils of a small motor whose armature is fed from an independent 60-cycle source. With this arrangement, when the cell receives a more intense beam from the standard than from the sample, the motor will be driven in one direction, when it receives a less intense one the motor will reverse, and when it receives equal intensities the motor will stop. By causing the motor to operate the shutter which regulates the amount of light reaching the standard white sectors, the two beams are automatically balanced. A pen records the position of the shutter on a rotating drum. The same drive that rotates the drum also varies the wavelength of the monochromatic light at a uniform rate from 4000 Å to 7000 Å. The resultant curve shows how much light reflected from the standard was equal to the amount of light reflected from the sample for every wavelength in the range. It therefore gives the reflection coefficients of the sample as percentages of those of the standard. If absolute coefficients are desired, correction factors may be applied.



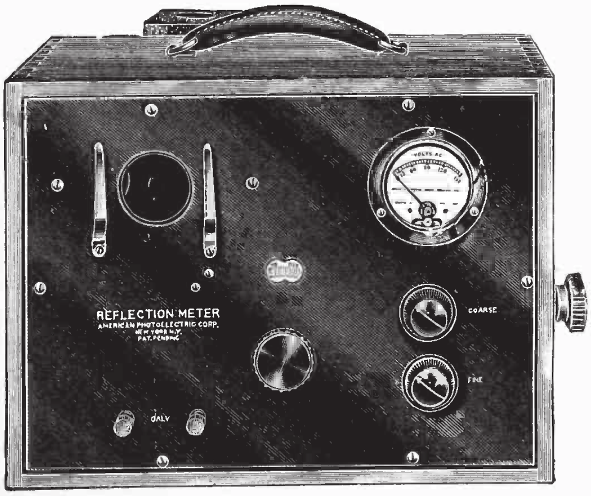
Recording color analyzer of General Electric Company

The American Photoelectric Corporation has developed a spectrophotometer which is built by Eimer and Amend. There are three modifications of the instrument, one to give transmission curves in the visible spectrum, one to give reflection curves and the other to determine relative energy distribution in the ultra-violet. Each instrument essentially consists of (1) a carrier for the sample, (2) a light source, (3) a spectrometer to segregate the lines or bands of the desired wave lengths, (4) the case containing the photocell unit, electrical circuits, amplifiers, control panel, etc., (5) a galvanometer, and (6) a Wheatstone bridge, usually one of the Kohlrausch type.[2]

In obtaining a curve, the wavelength setting is made and then a circuit is balanced twice, first without the sample and then with the sample inserted. The desired coefficient is then read from a dial directly calibrated in absolute percentages. A curve can be drawn from a sufficient number of such readings, each reading requiring from 15 to 20 seconds.

Different types of light sources and photocells and different makes of galvanometers, bridges, and spectrometers can be used without affecting the readings more than 0.1 per cent.

Significant facts about an oil can be deduced from its color curve.[3] As an example, it is shown that two peanut oils, although having different colors, have similarly shaped color curves which indicate their similar chemical constitution. Also, a peanut oil and a mustard oil that have the same value on the Lovibond scale, have unlike color curves which indicate their different structure. Since the same method can be applied to fats, waxes, soaps, etc., and can be extended into the ultra-violet and the infra-red, it can be of great assistance to industrial and academic research.



Color analyzer for transparent substances made by American Photoelectric Corporation. Range —visible spectrum

A modification of the instrument, useful in pyometry, will detect changes as small as one degree in the temperature of a material under heat treatment.

The Colorscope designed and built by Dr. H. H. Sheldon

Color comparators

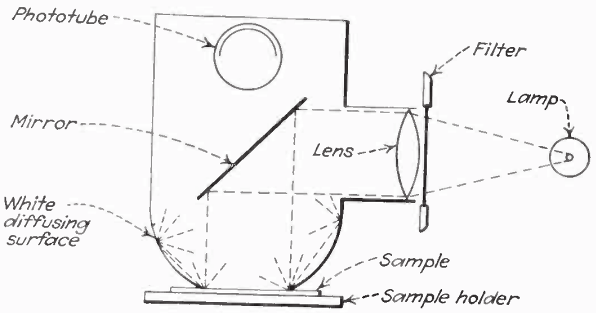
In operation, color comparators determine whether two samples reflect or transmit equal percentages of incident light. Their function, the detection of visual color matches, is accomplished by making four observations, one with white light and the other three with the three primary colors. A non-match can sometimes be detected under white light, that is the cell will not receive equal amounts of light from the two samples. But if it does, there is not yet any assurance that a good match exists. However, if the two samples reflect or transmit, equal amounts of red, green, and blue light to the cell, they will appear to the eye to have the same color under all ordinary illuminations. In the comparators described here, tricolored filters are provided for making matches in this way. Their use is also helpful in correcting differences in color. Knowing in what portion of the spectrum the difference lies, it is possible to make an estimate of what colors should be added to one sample to make it match the other.

The Colorscope, manufactured by the Sheldon Electric Corporation of New York City, finds its widest use in the textile industry because it is especially adapted to the measurement of Fadometer and Launderometer results and to the correction of misdyes. It is a bridge, two arms of which are matched photocells. The samples are placed in holders which rotate them, and the photocells see these rotating samples by indirectly reflected light. This feature avoids error which the effect of weave, texture, or sheen might cause and allows such comparisons as wool with silk, or glossy paper with a rough sheet, on a color basis alone.

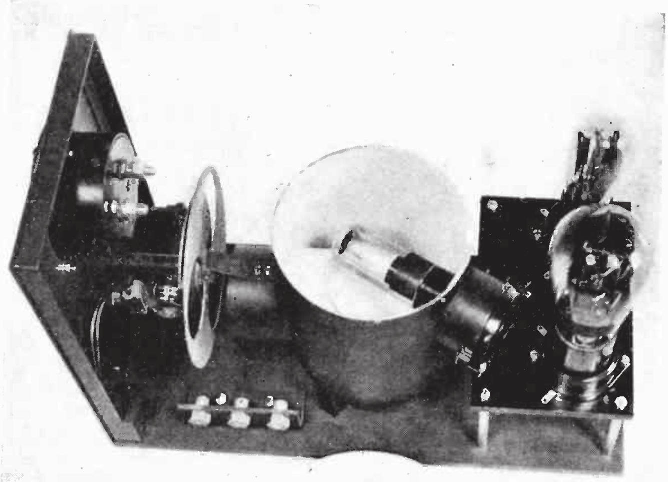
As the samples are rotated, the operator balances the bridge by varying a resistance until the galvanometer reads zero. Then the samples are interchanged in position before the photocells and rotated again. Any resultant meter deflection shows that the bridge is no longer balanced and that one sample is redder, or bluer, etc., than the other. Because the method of obtaining balance makes these deflections proportional to difference in color alone, the meter is calibrated to give percentage differences.

This feature gives the instrument certain advantages. It permits the matching of dull dark surfaces with the same precision as light ones. It also allows the operator to select some small percentage as a tolerance and use it throughout, regardless of depth of color. And the direct calibration in percentage gives quantitative information for the correction of misdyes.

Standard tiles are provided with the instrument for



Schematic of the Westinghouse color matcher



Westinghouse photoelectric color matcher

checking it each day, and a sensitivity control is used to correct any variations in the photocells.

The Westinghouse color matcher is designed to compare plates, textiles, paint samples, etc., and with minor changes, semifluids, pastes, powders, coffee, corn flakes, and so on. A sensitivity control is used to make the amplified output of a photocell bring a meter needle to midscale when the standard is in place. Then with the standard removed and the sample in place, the needle detects a match.

The electrical sensitivity is fixed; the hue sensitivity varies slightly, being more sensitive for bright materials than for dark ones. In all cases, however, the surface condition (glossy or dull) makes no difference in the color match.

The General Electric color comparator utilizes a photocell and amplifier, but in this case there is a bridge, one arm of which contains the plate circuit of the last amplifying tube. The method of use is that of balancing the bridge with the standard in place and then inserting the sample. Its accuracy is as good as that of the eye in all matches and better in the end regions. It is not calibrated because its sensitivity depends on the photocell. However, the operator can set his own tolerances for each material and check them from time to time.

A set of gray reflection standards comes with the instrument for the purpose of checking and estimating sensitivity.

American Photoelectric makes two instruments which match the total transmission of similarly colored liquids. One of these instruments, the advanced model, contains a bridge in which two arms are photocells. It can be used as a comparator or as a turbidity meter. When used as a comparator, the bridge is balanced with the standard and the sample each viewed by a photocell in the bridge. Interchanging them will then show if they match to 0.05 per cent.

As a turbidity meter, the instrument uses the Tyndall beam method and so gives values directly only when the size and concentration of suspended particles is small. But its range can be extended by interpolation between readings on similar solutions of known concentration. Readings are obtained in one or two minutes and are claimed to be more accurate than those usually obtained by evaporation. The other A.P.C. comparator contains one photocell in a bridge and matches total transmission less precisely than the advanced model.

Total reflection factors can be measured by a third A.P.C. instrument, useful in the textile and paper industries because it also measures opacity and translucency. In measuring total reflections with this instrument the standard is illuminated by a normal beam of collimated light and viewed by two photocells at thirty degrees from the surface. The output of these cells goes to a galvanometer and opposes the output of a third cell which receives light directly from the source. The galvanometer is brought to zero reading by a variable resistance and then the standard is replaced by the sample. This time the galvanometer is brought to zero by a slide wire which is calibrated to give directly the reflection factor of the sample as a percentage of that of the standard.

Measuring opacity and turbidity

Opacity is defined as the ratio of a material's reflection coefficient when backed by a non-selective black body to that when it is backed by a non-selective white body. To measure opacity with this instrument, therefore, observations are made first with the sample backed by a block of chalk, and then with it backed by a box whose inner surface is mat black. Translucency, being defined as one minus opacity, is easily derived.

The Exton Scopometer of Bausch and Lomb is a one-variable instrument designed to measure turbidities or total transmission of any liquid. It is most used in making blood tests. Referring to the figure, aperture of the diaphragm is varied by a micrometer screw until the galvanometer reads zero and the reading taken from a turnscounter on the screw.

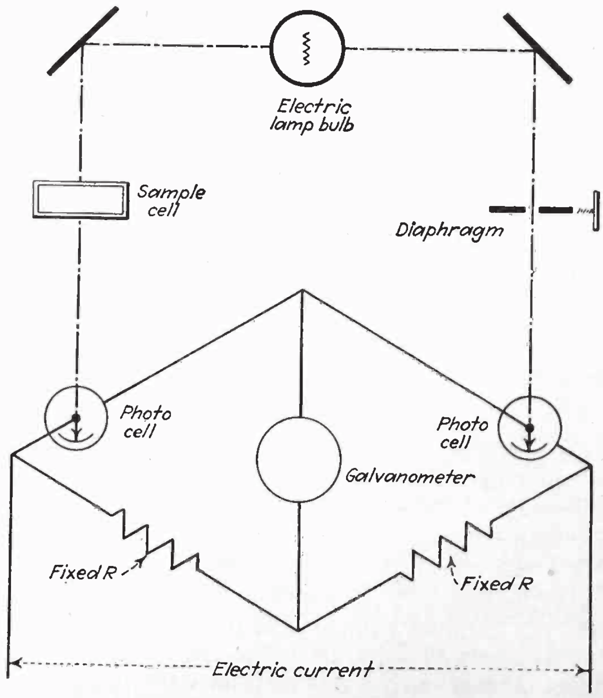
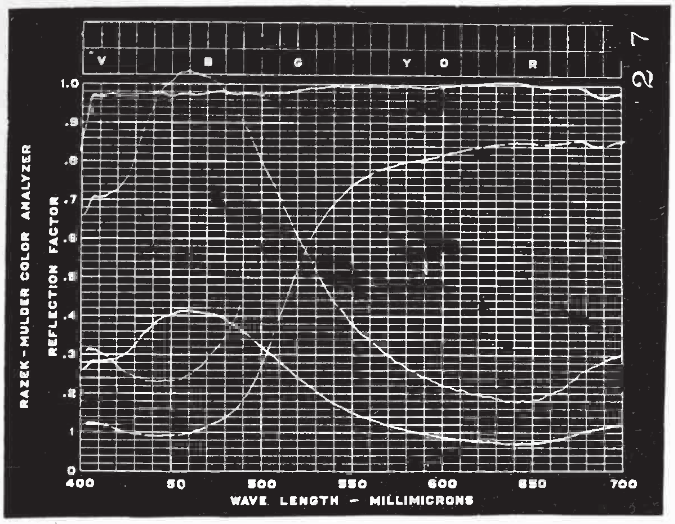


Diagram of connections of the Exton Photoelectric Scopometer sold by Bausch and Lomb



Reflection factor record (Razek-Mulder color analyzer) of a blue (left hand curves) and a yellow sample. The top curve is the standard record of magnesium carbonate

The Zeiss Recording Photometer[4] is a one-variable instrument, for obtaining intensity analyses of photographically recorded spectra. A negative on which the spectral lines have been recorded is moved at a uniform rate between a light source and a photocell. The current from this cell goes through a constant resistance and the voltage drop across this resistance is applied to a Wulff single thread electrometer. The position of the thread is recorded on a moving photographic plate, the result being a continuous intensity curve. If it is desired to stretch this curve out to show up details, the recording plate may be made to move anywhere from 1 to 500 times as fast as the object. The instrument sensitivity is controllable by varying the illuminating lamp voltage, the curve is sharply defined even for full scale deflection, and provision is made for watching the electrometer thread during operation.

There are, of course, a great many other photoelectric instruments which measure density, brightness, etc., but because they are not closely connected with color measurements they have been considered outside the scope of this article.

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[2] "Photoelectric spectrophotometer," *Instruments*, Feb. 1930.

[3] "Photoelectric color measurements," *Oil and Fat Indust.*, vol. 7, No. 1, 1930.

[4] For full description and bibliography, see *Zeiss Bulletin*, "Photoelectric recording photometer."

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C. H. Sharp, "Various applications of the photocell with amplifier to photometry," *Journ. Opt. Soc. Amer.* 13, 304 (1926). (Description of method used at Electrical Testing Laboratories.);

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A NEW BOOK ON ELECTRON TUBES

Theory of thermionic vacuum tubes

By E. L. Chaffee, McGraw-Hill Book Company, New York, N.Y. 639 pages. Price, $6.

THIS BOOK WILL APPEAR as one of the electrical engineering texts issued under the editorial chairmanship of Professor Harry E. Clifford of Harvard University. This in itself would be sufficient to recommend it, but a careful examination is necessary to comprehend the enormous amount of detail required to set forth the theory of the thermionic tube with the rigorous standard which Professor Chaffee has set. The present volume deals with the physics of the tube, and its use as a rectifier and amplifier. The tube as a generator of undamped oscillations, and as a rectifier will be taken up in the second volume.

The introduction gives a short history of thermionic theory from the first observation in the seventies to the present day status. This is followed by chapters on the structure of matter and conduction through gases. Two chapters deal with Thermionic Emission and Practical Sources of Emission. Professor Chaffee presents in an impartial manner with complete tables and curves the controversial data regarding the constants in the emission equation. The results on oxide-coated filaments are summarized with a theory which leans toward the point of view that a monatomic film of the active metal does the emitting, and is continually renewed by electrolytic conduction from below.

The letter symbols and nomenclature used thereafter in the book are followed by a treatment of the static characteristics of the triode in dependence on its structural parameters.

The dynamic measurement of the triode coefficients is thoroughly discussed, methods of balancing out the tube capacities being given. Effects of gas in a tube are taken up, and a set of complex coefficients for a soft tube developed. In view of the work on positive ion tubes reported on by Dr. Hund last year, it would appear that this material will have some application in the immediate future.

A rigorous derivation of the input admittance of a tube, resulting in a "generalized equivalent plate circuit theorem" precedes a general discussion of the gains in different types of single stage amplifiers. A valuable section, of direct value to the receiver designer, treats the relative merits of different types of amplifiers for equal band width.

Regeneration in a triode is followed by an extension to the case of coupled circuits. In spite of the present day tendency away from regeneration, its inevitable presence on account of small coupling effects makes a rigorous treatment valuable.

A chapter each is devoted to resistance, impedance, and transformer-coupled amplifiers, the theoretical treatment being followed by descriptions of experimental set-ups for verification of the results developed by the analysis.

Treatment of small-signal detection precedes a description of laboratory methods for measuring the "detection coefficients." The relative merits of grid and plate detection are clearly brought out.

In the study of large signal detection, Professor Chaffee develops a new graphical method which has the merit of absolute rigor. Applications are made to the distortion errors produced in vacuum tube voltmeters. The "variable-mu tube" is discussed, and the question of low grid current tubes for amplification of minute voltages touched on.

In unqualifiedly recommending this book to the engineering profession, there is no need to indulge in superlatives. The book is complete and authoritative. It brings under one head a tremendous amount of material hitherto unpublished or scattered throughout the technical literature.

W. J. CAHILL.

HIGH LIGHTS ON ELECTRONIC

Photocell controls truck-garage doors

THESE DOORS OF THE TRUCK garage of the Westchester Lighting Company, Mount Vernon, N. Y., are 14 ft. high and are of the steel-curtain type which roll up. They are motor driven. "Open" and "Close" buttons at the side of the doorway furnish manual control. There are two buildings housing Westchester Lighting Company service trucks, each with a door of this type and each has been equipped with photoelectric control.

The buildings are heated by unit heaters. A great deal of heat was wasted formerly by truck drivers leaving the doors open, and the inconvenience of getting out of a large truck to open the doors and again to close them has been eliminated.

It was decided to place a photoelectric control on each of the exit doors as an experiment. This has been done and has been in successful operation for several months.

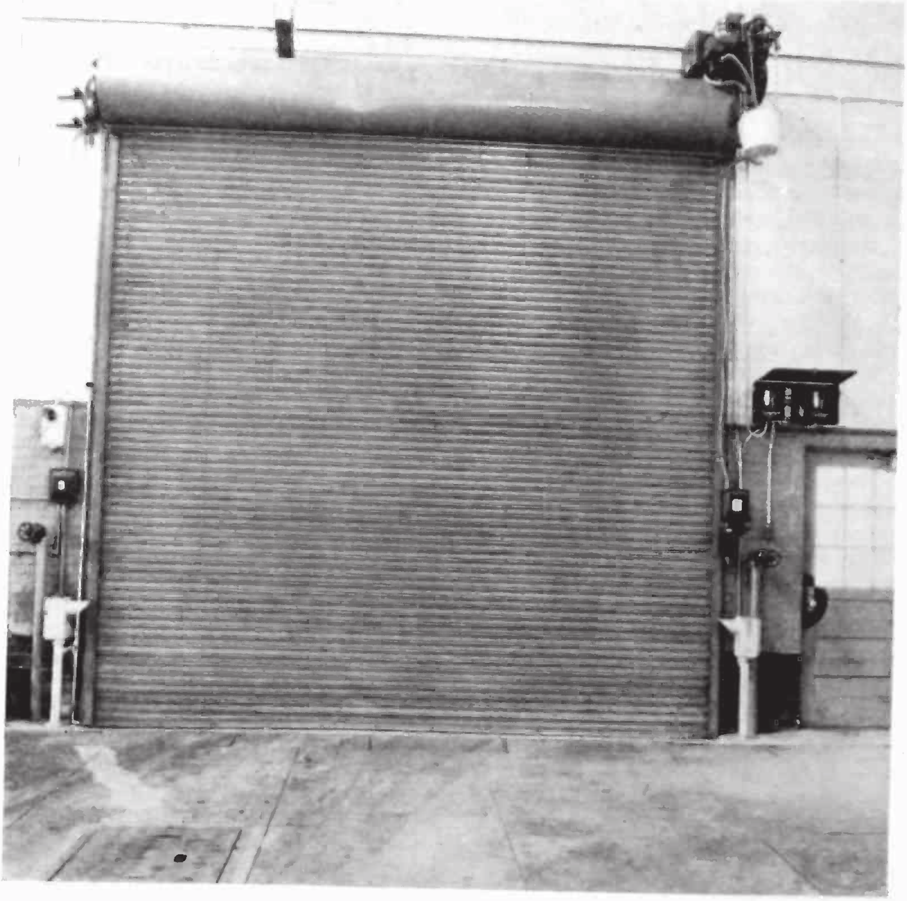
The following are features of this installation:

1. The doors open at the approach of a truck.
2. The doors are prevented from closing until the truck has cleared the opening.
3. The doors will stop if a person walks through the opening while the door is coming down.
4. A "stop" and "go" light inside (left of door) tells driver when to go and warns him to stop if the door is not fully raised or is coming down.
5. Another "stop" and "go" light actuated by the door regulates traffic outside the buildings in the yard.
6. Light rays are so arranged as to permit free movement of trucks and persons inside the garage without causing false operation of the doors.

One light projector is in a concrete pit in the floor and shines upward through a hole in a manhole cover to a phototube in a box over the doorway. When blocked, this ray opens the door.

The other projector shines a beam of light horizontally across the doorway, close to it. It is this ray that acts as a safety guard, preventing the closing of the door, even manually, until the truck has cleared the doorway. Blocking this ray will stop the door if it is coming down.

Another interesting feature of this installation is the fact that the limit switch actuating the "stop" and "go" lights also turns on a motor-operated valve which cuts off the steam supply to the unit heaters when the door is open. With cold air blowing on the garage attendants instead of hot, it is not likely that the doors will be left open very long—another reason for the continued use of the photoelectric control which will automatically keep the doors closed at all times. Everything is water-proof as floor is washed with high-pressure hose.



Light-projector pit is in the left foreground with manhole cover with hole in it for light to shine through. "Stop" and "go" lights are at the left part way up. Control panel containing two photoelectric and several auxiliary relays at the right over small doorway. Toggle switch below for disconnecting the photoelectric control

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Locating fish by submarine echoes

AT A RECENT MEETING of the New York Electrical Society, Dr. Herbert Grove Dorsey, U. S. Coast and Geodetic Survey, told how his invention, the fathometer, is being used by fishermen to locate depths at which certain types of fish congregate, thus greatly increasing the day's catch when the fishing fleet is properly located. Dr. E. E. Free, past-president of the Society, now reports a similar method employing submarine echoes to be used by the British Marconi Company.

A sound signal is created electrically on the ship, sent through the water to the sea bottom and its echo picked up as it returns to the surface. Knowing the time occupied by this echo and the speed of sound in sea water, it is possible to calculate how deep the water is at that spot. Users of this device are said to have noticed, in addition, that the character of the echo depends on the nature of the sea bottom. A bottom of soft mud gives an echo different from that of a bottom of sand or of jagged rocks. Soon it is expected to be possible to reduce these bottom indications to simple enough rules so that ships' captains can use the echo sounding device to learn the nature of the bottom underneath them as well as its depth. Similar modifications of the character of the bottom echo are observed when there are schools of fish part way down in the sea and it is expected that these indications, too, can be reduced to rules permitting fishing fleets to tell just where the sea underneath them is populous enough to make it profitable to let down the nets.

DEVICES IN INDUSTRY + +

15 miles of electron tubes to light World's Fair

Most modern of light sources, gaseous discharge tubes will be called upon to do their spectacular best at the World's Fair Century of Progress Exposition in Chicago. According to recent estimates, when the exposition opens formally in June it is probable that between 75,000 and 100,000 ft. of gaseous discharge lighting will be in use on the grounds.

Among the more interesting developments is the recently announced cascade of green and blue light produced by 1½ miles of gaseous tubes on the windowless walls of the electrical building. This waterfall effect will be horseshoe-shaped, following the contour of the electrical building. Seven banks of green and blue colored gaseous tubes will rise 55 ft. vertically at intervals along the walls. Spray and steam rising from pools at the bottom of the walls will heighten the cascade effect.

A total of 7,500 ft. of gaseous tubes will be used for this illumination spectacle—the largest amount ever utilized for lighting the exterior of a single building. The tubes will be exposed and produce direct light, instead of being concealed, as is the case with gaseous lighting effects elsewhere on the exposition grounds. There will be no obvious supports for the tubes, thus increasing the mysterious effect their light will produce.

In addition to the exterior lighting, extensive use of gaseous tubes is made in interior lighting in the electrical building. In the great semi-circular hall in which exhibits will be presented by leading electrical companies, manufacturers of electrical equipment and utility companies 1,250 ft. of red-colored tubing and 1,200 ft. of gold-colored tubing is being installed.

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New advertising possibilities with electron tubes

"The technology which produced radio broadcasting, seems destined to revolutionize advertising methods still further, both by providing wholly new electronic media now as little known as broadcasting once was, and by radically revising present printing methods," declared Orestes H. Caldwell, president of the New York Electrical Society and editor of *Electronics,* speaking before the Advertising Club of New York City, on the subject "New Things Up Radio's Sleeve for Advertising Men."

"Next year's radio sets may deliver you your morning paper when you come down to breakfast. By switching off the loudspeaker at bedtime, you would start a radio facsimile recorder which would receive and print your paper, headlines, cartoons, and all. Such facsimile newspapers are now being transmitted to ships in mid-Atlantic; plans for similarly hooking up home radios are complete, waiting only a good time for launching," said Mr. Caldwell.

"Talking books and talking newspapers will serve another class. Such talking books comprise short loops of film or paper, and will reproduce at any length. Such talking newspapers would also have the advantage of being brightened with songs and music.

"The electric-light wires are now being used in Cleveland to bring music and news by wired wireless—free of fading, static and distortion. Electric signs on country roads flash on when an approaching car's headlights come into view.

"In some fifteen different ways electric eyes are now revolutionizing the familiar processes of printer's ink," continued Mr. Caldwell. "Already linotypes set type directly from the reporters typewritten copy, without the presence of any operator. By photo-electric scanning, halftones are made directly from photographs in the time it takes the editor to write the caption. Simultaneously identical halftones might be produced in 40 cities. Color plates can be produced in half an hour, at a fiftieth the present cost. Electric eyes insure register in color printing; measure capacity; count sheets pouring through the bindery; and stop the presses in case of a paper break.

"Meanwhile radio broadcasting advances from a merely national scale, to a point of world coverage, so that an advertising message broadcast on short waves from a New York studio, may confidently be known to be picked up in Europe, South America, Africa and the Orient."

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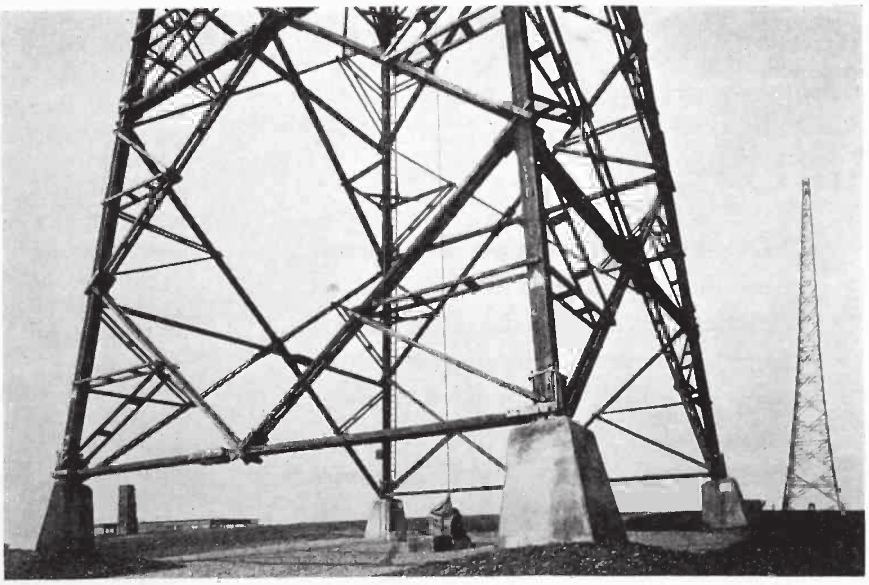
U. S. Navy's cathode-ray storm indicator

The Naval Research Laboratory, near Washington, has been working on a development of Watson Watt's method for determining the direction of static. The equipment consists of two loops at right angles. The four terminals of the loop are connected through a receiver to four plates of a cathode-ray tube fitted with an azimuth circle. Incoming signals produce a straight line on the face of the cathode-ray tube and the direction of the incoming signal is read from the azimuth circle. The equipment is resonant at about 13 kcs., according to Commander W. J. Ruble, assistant director of the Laboratory.

* * *

RADIO TOWERS OF CREOSOTED PINE



The Muhlacker radio station at Stuttgart, Germany, employs these 330-ft. towers built of creosoted Southern pine. Similar towers have been built to heights of 525 ft., according to Axel H. Oxholm, director of wood utilization, Department of Commerce, Washington

Bridge-type push-pull amplifiers

By LEONARD TULAUSKAS

IN THE compact radio receiver of today, the various components are crowded so greatly that coupling of greater or lesser degree exists between all parts on the chassis. This does not present very great difficulties in the design of the radio frequency portion of the receiver but on account of the large field around the power transformer and filter choke (the field around the choke is particularly strong when choke input is used as with the 83-type tube) the amount of hum voltage induced in the audio frequency wiring is considerable and in most cases can be eliminated only by careful routing of the wires. While this represents a satisfactory solution for the amplifier terminating in a single output tube through a resistance-capacity coupled detector, it is of little avail where a transformer coupled push-pull output stage is used. In the latter case, the size of the input transformer is so great, relatively, that the hum pickup is mainly determined by the voltage induced in this transformer from stray fields instead of by the rest of the audio frequency wiring. It might also be pointed out that in general it will be impossible to mount the input transformer in such a position that cancellation of hum occurs unless the fields of the power transformer and filter choke are symmetrical with each other and are so far removed from each other that the audio-frequency transformer is subjected to the field of one alone.

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FOR many years the omnipresent push-pull amplifier circuit remained practically unchanged. Its freedom from harmonics and hum, and its comparatively high output have made it indispensable to the modern radio set. Present day space—and cost—requirements, however, have brought interesting and useful modifications of the original circuit into popular receivers.

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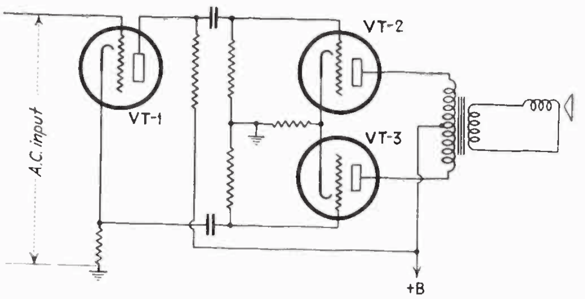


Fig. 1—Method of driving push-pull stages from a single tube by resistance coupling

This problem was overcome by one radio manufacturer by using output pentodes in parallel instead of push-pull, thus making possible resistance coupling instead of transformer coupling to that stage. A suitable pad consisting of the tone control resistance and a condenser in series with it was shunted across the primary of the output transformer to prevent the load impedance from rising too high at the upper audio frequencies. At 6 watts output this amplifier produced only 10 per cent total harmonic distortion compared to about 9 per cent for a similar push-pull arrangement. In order to compensate for the reduced low frequency response caused by the large direct current flowing through the primary of the output transformer, however, some low frequency regeneration was introduced so the over-all response was very satisfactory.

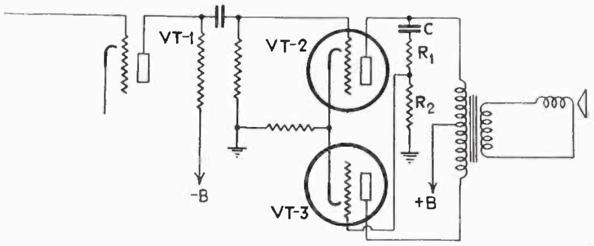


Fig. 2—Circuit in which the second of two push-pull tubes gets its excitation from the first tube output

While the arrangement described above was used to eliminate hum and for no other reason, it would prove quite expensive in comparison to the cost of some other schemes to be described. These circuits are all of the push-pull type primarily because of the even harmonic cancellation which occurs in the output circuit and which make an impedance adjusting pad unnecessary.

A highly satisfactory scheme is shown in Fig. 1. The voltage developed across the cathode series resistor is practically 180° out of phase with the voltage across the plate load resistor. By suitably proportioning the two resistors, voltages equal in magnitude, but 180° out of phase will be delivered to the grids of the push-pull tubes. Although *Vt*-1 is shown as a triode in the diagram, a tetrode or pentode may be used with even greater advantage. Likewise, the output tubes may be triodes or pentodes working as class A amplifiers. This type of circuit has found considerable favor in Europe and has also found some application in sound recording amplifiers for motion pictures. It might be well to point out at this point that in general the heater of *Vt*-1 must be connected to a separate winding on the power transformer.

In the above circuit, the voltage applied to the grid of each push-pull tube was only one-half of the total voltage developed by the phase splitting tube. This means that the total audio frequency gain is reduced by one-half, which may be insufficient amplification for some purposes. The circuit shown in Fig. 2 impresses the entire voltage developed by the driver tube on the grids of the push-pull tubes. A simplified explanation of the action of the circuit is as follows: C is quite large in value so that it offers a low reactance to the audio spectrum. R_1 and R_2 act as a voltage divider across the upper half of the output transformer which presents a resistive load to the tube (except at speaker resonance). Consequently, the voltage developed by *Vt-2* across this load is divided in the ratio of the two resistors; a definite portion is impressed on the grid of *Vt-3*. This voltage is 180° out of phase with the input voltage to *Vt-2* by virtue of the phase shift occurring in that tube. True push-pull action will occur when the voltage on the grid of *Vt-3* is equal in magnitude and opposite in phase to that on the grid of *Vt-2*. If R_1 and R_2 are large compared to the reflected load resistance, then the voltage developed across the output impedance of *Vt-2* can be closely represented by the following equation:

$$E_2 = \mu_1 E_g \frac{R_p}{R_p + r_p}$$

where

E_2 = a.c. voltage developed across load resistance.
μ_1 = amplification factor of *Vt-2*.
R_p = reflected load resistance.
r_p = plate resistance of *Vt-2*.
E_p = a.c. voltage impressed on grid of *Vt-2*.

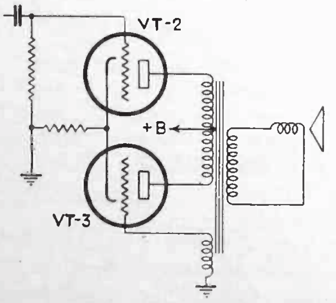
It is desired that the voltage across the grid of *Vt-2* be equal in magnitude to E_g as it was previously shown that it will be in opposite phase. Therefore

$$\frac{R_2}{R_1 + R_2} \mu_1 E_g \frac{R_p}{R_p + r_p} = E_g$$

Cancelling,

$$\frac{R_p}{R_p + r_p} = \frac{R_1 + R_2}{R_2}$$

This equation is important for several reasons. First, it indicates the correct proportioning of the various resistors to secure equal grid voltages. Second, it shows that this equality is preserved regardless of the grid excitation. Third, if the voltage across the load resistance is given as $i_p R_p + j i_p \omega L$, it will be found that ω drops out indicating that the voltage division is independent of frequency. This seems to be an ideal way in which to obtain a single-ended push-pull amplifier but some experimental work showed immediately that considerable difficulty could be expected.



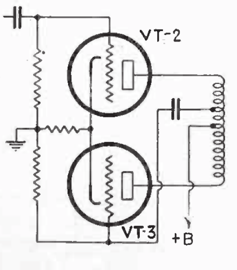


Fig. 3 Left—An experimental method of connecting push-pull tubes

Fig. 4 Right—Final method of exciting second of two push-pull tubes

Referring again to Fig. 2, it will be noted that *Vt-3* is connected in the circuit in much the same fashion as a Hartley oscillator. Consequently, it will oscillate at one of two possible frequencies; that determined by the leakage inductance and stray capacity of the circuit or the natural period of the loud speaker. The high frequency oscillation can be readily eliminated by shunting a pad consisting of a condenser and resistor in series across the primary of the output transformer. The low frequency oscillation is extremely difficult to subdue; when eliminated, the power output is greatly reduced. It is also possible to use two condensers in series as the voltage divider instead of R_1 and R_2. This reduces the tendency for high frequency oscillation but seems to aggravate the condition at resonance.

Another scheme is shown in Fig. 3. This arrangement was quite satisfactory except that the amplification was low at the higher audio frequencies. This condition was remedied by using an output transformer in which the tertiary winding was interspersed throughout the primary by means of pies. However, the cost of such a transformer was too high for use in production receivers.

The final arrangement adopted is shown in Fig. 4. This is very much the same as the above except a tap is utilized on the primary as a step down auto-transformer instead of making use of the separate winding. As expected, the fidelity of this arrangement closely approached that of the final model shown in Fig. 3. The criterion of performance of such an arrangement can best be judged by a consideration of the power output vs. per cent distortion curve. Fig. 5 shows such a curve for this amplifier with 47's in push-pull in the output stage. It is significant that from 6-7 per cent distortion at 2.5 watts output is obtained from a single 47 tube, while the curve shows this push-pull arrangement exhibits only 2.5 per cent distortion at the same output.

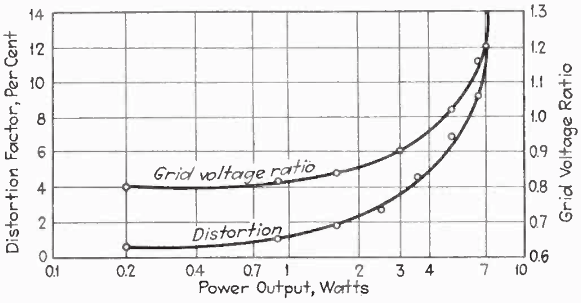


Fig. 5—Output characteristics of bridge-type amplifier using push-pull 47 tubes

The ratio of the a-c grid voltage on the driver to that on the driven tube is shown in Fig. 5 also. Note the corresponding rise in distortion as the grid voltage ratio changes. While the theoretical consideration of this circuit indicated a constant grid voltage ratio, actually, the change in plate resistance of the tubes at extremely large grid swings is great enough to upset the balanced condition existing under normal loads. At reasonable output levels, the balanced condition holds very well and for this reason this circuit is known as a bridge type push-pull amplifier.

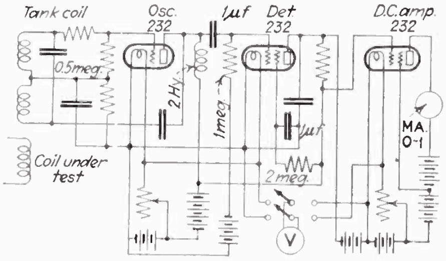
In conclusion, the writer wishes to express his thanks for the original details of this circuit to Mr. W. W. Dunn of the Grigsby-Grunow Company and to acknowledge the efforts of Mr. Leidy of the Chicago Transformer Company to produce the experimental and final transformers for the amplifiers.

+ + ELECTRONIC NOTES

A shorted-turn indicator

By C. G. Seright

Neither an inductance nor a d.-c. resistance test will reliably evidence a single shorted turn unless the winding consists of relatively few turns. The best way to test for shorted turns is to couple the coil inductively to an a.-c. circuit, and measure the power drawn from that circuit. A good coil will absorb negligible power; one containing an internal short will absorb energy at a rate depending on the number of turns shorted, the tightness of the coupling, the frequency of the induced emf., and the impedance of the shorted section.



The rate of absorption increases with frequency, but the frequency must be low enough that no appreciable current flows through the distributed capacity of the tested coil, as such capacity currents cause spurious absorption in good coils.

For large coils, such as transformer and filter-choke windings, suitable apparatus consists of an "E" shaped iron core carrying windings connected in a "balanced" circuit, an amplifier, and an uncalibrated vacuum tube voltmeter. The tested coil is slipped over an outer leg of the core, and if it contains shorted turns, the coupling circuit is unbalanced, and the unbalance indicated by the V. T. voltmeter. The central leg of the core is excited with a.-c. from the power mains.

Other types of coils, such as those wound on integral spools, and loudspeaker voice-coils with centering spiders, cannot be tested on an iron core coupling device. For such coils, the writer constructed a shorted turn finder of different design.

Since a test frequency many times higher than 60 cycles was permissible for these small coils, a vacuum tube oscillator was used as the a.-c. source. The operating principle is that an oscillator's tank circuit voltage will vary in accordance with the rate of absorption of energy from the tank circuit. The tested coil was coupled to the tank inductance, which was coupled to a detector, the detector in turn actuating a d.-c. amplifier having the indicating milliameter in its plate circuit. Any absorption by the tested coil resulted in reduced detector input, and a consequent reduced reading of the indicating meter.

A type 230 tube was used as the oscillator. A resistance network in its grid circuit prevented high damping of the tank circuit oscillations during positive grid voltage excursions, reduced the input voltages to the tube, thereby curtailing harmonics. Large harmonics were to be avoided because of their greater tendency to set up spurious absorption currents in a tested coil. The oscillator was tuned to approximately 8,000 c.p.s., the highest permissible frequency for the largest (electrically) type coil to be tested.

The tank inductance used consisted of 950 turns of No. 20 enameled wire, compactly wound in solid layers, with thin paper between layers. The winding cross-section was approximately $1\frac{1}{8}$ in. square. The window of the winding was just slightly larger than the largest diameter coil to be tested. The tank coil was housed in a protective bakelite shell; and mounted on a tilt of 45 degrees near the bottom of the test panel, directly under the indicating meter.

One-half the tank circuit a.-c. voltage was impressed upon the detector which was supplied a compensating negative bias of 45 volts through 1 megohm. Thus, small variations in peak input voltage were thrown upon the straight part of the E_g–I_p curve, giving maximum detecting efficiency.

The d.-c. amplifier was operated by separate batteries, the only connection to the remainder of the circuit being the 0.5 meg. resistor common to the detector plate and the amplifier grid circuits. Since this resistor put a positive bias on the amplifier grid, a counteracting bias battery of $22\frac{1}{2}$ volts was included in the grid circuit to keep the amplifier plate current below 1 ma. The normal plate current was thus set at approximately 0.8 ma. a downward swing indicating shorted turns.

The only adjustment necessary, preparatory to testing, was setting the filment voltage. To test a coil, it was simply inserted into the window of the tank coil. A large reduction in the reading of the milliammeter indicated shorted turns, good coils giving practically unchanged deflection. One closed turn one-half inch in diameter of No. 35 wire would reduce the indicating meter deflection 0.6 ma. This was the smallest turn of the finest wire in any coil to be tested, representing therefore the smallest absorption to be indicated. (An equivalent shunt leakage in the insulation of an entire winding would, of course, produce a similar reading.) On the other hand, the largest coil (electrically) to be tested showed a change in deflection due to distributed capacity effects of less than 0.1 ma.

Square-top filters

Band-pass filters as used with straight t-r-f sets have the disadvantage that the width of the band does not remain constant over a wide range of frequencies. In the case of superhets the filter can be placed ahead of the i-f amplifier and rendered more effective as it has to deal with one frequency only.

When (Fig. 1), taken from an article in *Hochfrequenz und Electro Akustik*, 41:23-26, 1933, by H. Piesch, the grid of the first i-f amplifier tube is shunted by a parallel resonant circuit (L,R in parallel with C), a small condenser Δc in series with the resonant circuit, the voltage will build up to a maximum at the resonance frequency of the parallel circuit $f_0 = 1/6.28\ \sqrt{LC}$, while the resistance will drop to near the short circuit condition near the frequency $f_1 = 1/6.28\ \sqrt{L(C + \Delta c)}$. By taking Δc fairly small in comparison with C, a steep cut-off may be obtained somewhere between these two frequencies.

If, moreover, a parallel resonant circuit (L,R in parallel with $(C - \Delta c)$), and, in series with it, a second small condenser Δc, are inserted in one of the leads before it comes to the grid of the amplifier tube, there will be a considerable voltage drop in this lead at the resonance frequency, $f_2 = 1/6.28\ \sqrt{L\ (C - \Delta c)}$, and a relatively small drop for the frequency $1/6.28\ \sqrt{LC}$ with a steep fall in voltage on going from one frequency to the other. The amplification can be limited to a nine or ten kc. band by suitably choosing the circuit constants (Fig. 2).

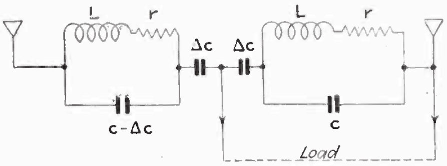


Fig. 1

The device is not only a band-pass filter, it also acts as an amplifier. Let e be the voltage input to this filter circuit, and E its output voltage. When resistance of coils and condensers need not be considered,

$$\frac{E}{e} = \frac{[1-p^2LC\ (1-s)]\ [1-p^2LC\ (1+s)]}{[1-p^2LC\ (1-s)]\ [1-p^2LC\ (1+s)] + (1-p^2LC)^2}$$

where $p = 2\ \pi f$ and $s = \Delta c/C$. The value of this fraction is equal to unity for $1/6.28\ \sqrt{LC}$, but soars to high values for the limiting frequencies f_1 and f_2. Within this band, on both sides of f_0, the fraction is somewhat larger than unity with a peak at two frequencies which depend on the ratio s.

FROM THE LABORATORY

With $s = 0.15$, and $f_0 = 75$ kc. as the i-f, these two enhanced frequencies are 79 and 71 kc., that is, they are close to the complete cut-off.

When the resistance of the coil is taken into consideration, the top of the band becomes flattened and the cut-off less complete. It is also important that the capacity of the load into which the band-pass filter delivers energy be kept as small as possible, not more than a few $\mu\mu f$. If in the above example, the load represents a capacity of 0.015 C or 0.15 Δc, the frequencies for which the amplification reaches its highest value lie near 77.25 and 72.4 kc. and much of the square-top effect is lost. Loose coupling of amplifier and filter is an advantage in this respect.

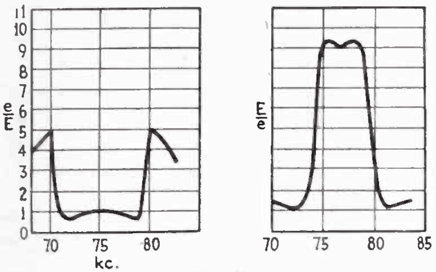


Fig. 2

Measurements with the aid of a vacuum-tube voltmeter, on a band-pass filter having a resonance frequency of 77 kc. and a band-width of 5 kc. show the steep cut-off despite the fairly high input capacity of the voltmeter (Fig. 2). The amplification at resonance is lower than near the cut-off frequencies, but this defect serves to square off the top of the band if, as is usual in European superhet sets of simple design, an r-f amplifier follows the antenna.

On the other hand, by throwing the shunt out of tune, the amplification may be made to fall with the frequency so as to obtain a compensation with regard to the a-f stages.

✦

Radiation by antennas without and within reflections

Through the courtesy of the Goodyear-Zeppelin Corporation a small non-rigid dirigible was available for measuring the field distribution around a vertical half-wave antenna, operated at a frequency of 29 megacycles per second (10.345 m.) and suspended one-eighth of a wave-length over water. The results at distances greater than 50 wave-lengths are in good agreement with Sommerfeld's formula, below this distance Strutt's approximation holds except near the surface of the water. (The latter formula gives a dead zone at any altitude over points about 50 wave-lengths from the antenna.) These measurements are reported in *Publications from the M.I.T., Serial 85*, 1933, reprinted from *Proc. I.R.E.*, by J. A. Stratton and A. H. Chinn, Mass. Inst. Techn.

G. J. Elias and C. G. Van Lindern, of the Inst. Techn., Delft, report in *El. Nachr. Techn.* 10:1-8, 1933, work on 54-m. and 81-m. waves which were received on vertical half-wave aerials or frames and sent from horizontal antennas. These waves are reflected at the lower conducting layer during daytime. When there is a single reflection the registered field intensities show a series of regular highs and lows in the course of five minutes which are to be ascribed to the rotation of the plane of polarization in the sky-wave which interferes with the ground wave. The altitude of the reflecting layer varies with the height of the sun. When the path of the ground wave is obstructed by buildings, the fluctuations in amplitude are slight.

✦

Calibration of low audio frequencies

By Earl R. Meissner

A convenient method of calibrating the low frequencies of an audio oscillator is to use an electric clock. Now most oscillators do not deliver sufficient power to drive the ordinary house clock. However the power stage of an a.-c. radio makes an excellent amplifier, especially if it will deliver three to four watts which is the power required by most clocks. Of course this power must be delivered at a voltage somewhere near the line voltage previously used by the clock.

Using a clock of the "manual start" type frequencies from 30 to 130 cycles can easily be measured. For frequencies higher than this it is necessary to insert a condenser in series with the clock of such a size so as to tune the circuit to resonance. This extends the range of frequencies up to 240 cycles. The series capacity required at this frequency is approximately 0.045 μf. The clock is naturally harder to start on the higher frequencies but with practice one learns to do it readily.

The procedure in measuring a frequency is to start the clock and then by means of another timepiece, note the number of minutes recorded by the clock running on the unknown frequency in a given interval of time. The unknown frequency can then be calculated by the relation:

$$f_x = \frac{T_c}{T_a} f_c$$

Where f_x = Unknown frequency in cycles per second.
f_c = Frequency of which clock keeps correct time in cycles per second.
T_c = Interval of time recorded by running on unknown frequency.
T_a = Actual interval of time as acted by watch or other accurate timepiece.

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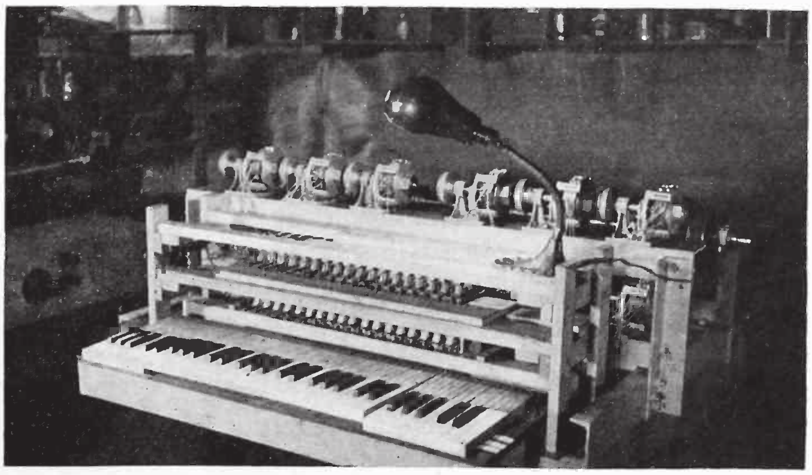
ELECTROSTATIC PIANO



A keyboard musical instrument based upon purely electrostatic principles has been developed by G. W. Demuth, 320 S. Minnesota Ave., Wichita, Kan. Waveforms can be controlled very simply by the shape of the electrodes, and many such generators can be compactly assembled in a keyboard cabinet

electronics

McGraw-Hill Publishing Company, Inc.
330 West 42d Street
New York City

O. H. CALDWELL, *Editor*

Volume VI —MAY, 1933— Number 5

Trial brings out new unexpected possibilities

REPEATEDLY, experience with electron tubes is showing that when an installation is undertaken first for some simple purpose or function, eventually some new and unexpected possibility turns up, and then the new electronic technique proves itself invaluable.

One of the best examples of this is in the control of spot and resistance welding by gaseous tubes. Such tubes were first proposed to take the place of the noisy large contactors that suffered undue wear and tear, and had a certain speed limitation in large sizes. However, once the substitution was made, ingenuity soon found a way of timing the welding cycles to a degree and in a manner that could hardly have been foreseen when planning only the direct substitution.

Styling radio sets for increased sales

RADIO men who have the problem of styling their sets for modern sales conditions, will find that in all classes of merchandise, the persons charged with buying retail stocks recognize that there are three taste levels into which purchasers can be divided. 1. The style leaders, the "smart set," small in numbers and unimportant in volume, yet influential because of their effect on future requirements by the masses. 2. The great middle class, comprised of thrifty, careful, discriminating buyers, who make up by far the largest number and are of chief importance in any merchandising situation. 3. The "price" buyers who purchase solely on the basis of expediency and price, and to whom quality and artistic design have small appeal. This expediency class also is limited in numbers.

It is the great middle group of sensible, careful purchasers who represent the principal prospects for any type of merchandise. Though conservative, this group responds to artistic design and quality. In the words of a merchandiser who annually places vast orders for a large merchant organization, "Artistic design always pays."

The electron tube— a reliable tool

FACTORY managers and industrialists, potential users of electron tubes, often express their doubts as to the reliability in operation of such tubes. The statement is made that if such tubes would last longer they would prove economical to install and use.

The truth is that tubes have been in service long enough to demonstrate their thorough reliability. The railroads have in operation over 12,000 tubes. Records indicate that these tubes have an average life approaching 3,000 hours. The reason is not difficult to find. A 25-watt incandescent lamp, with a life of 1,000 hours, is considered reliable. It operates at a filament temperature of 4,000 deg. F., has a filament approximately 20 inches long and 0.00118 in. in diameter. The train-control tubes operate at 3,140 deg. F., have a filament two inches long and 0.004 in. in diameter,—about ten times the cross-section of the lamp filament. The sturdiness of this filament and its lower operating temperature are both in the direction of long life, and freedom from filament breakage.

In elevator service, the tubes will probably last much longer than this figure of 3,000 hours. Although the filaments are heated continuously, the tube is loaded only when the elevator is leveling. Furthermore such tubes are much less subject to vibration. It is important too to realize that even if the tube fails, the elevator comes to rest near a floor automatically, and can still be operated as a manually-controlled vehicle.

The completely controlled elevator uses five tubes; the elevator with tube-controlled levelling only uses but three tubes. Thus the expense of tube upkeep is extremely small.

"Facsimile" to the aid of the broadcasters

DIRE plans are apparently underway among the newspaper publishers for the elimination of broadcasting-program material from their reading pages. Unfortunately the newspaper men look upon radio as something competitive, and they are unwilling to give the new agency further support.

Broadcasting needs advance printed programs to which listeners can refer. Mere oral announcements of program features to come are ineffective, except in the case of single outstanding events.

But the radio industry has its own defensive means all ready, in the shape of facsimile reproduction. The radio listener of the near future, when turning off his receiver on going to bed, might merely switch it over onto "facsimile"; the receiver would then go on recording during the night. And on coming down to breakfast next morning, the listener would find issued from his set his morning tabloid newspaper,—headlines, cartoons, radio programs, and all.

In the situation now developing between the broadcasters and the newspapers, radio has facsimile up its sleeve and can put it to good use in delivering printed program schedules, if necessary.

NEWS NOTES

British Television Society—The fourth exhibition of television and photo-electric apparatus of the Television Society of London, was held at the Imperial College of Science, South Kensington, London, April 5 and 6.

Broadcast and receiver engineers meet—Radio problems linking broadcast transmitters and receiving sets were discussed at a joint meeting, April 8 at New York, of the NAB committee under J. A. Chambers, chairman, and the RMA committee under Virgil M. Graham, chairman. E. L. Nelson represented the I.R.E. and R. A. Hackbusch was present for the Canadian R.M.A. Subjects of transmitter "hum" and radio reception standards were covered.

Bill restricting short-wave sets on autos opposed—Radio interests have appeared at committee meetings of the House of Representatives, protesting against the bill introduced by Congressman Louis Ludlow of Indiana, which would restrict the use of short-wave receivers on automobiles, without special license from local police authorities. While the bill is intended to prevent criminals from listening to police-calls, the opposition points out that it would have little effect on criminals, while greatly restricting legitimate users of short-wave receivers.

Electronics division of Hygrade-Sylvania—A complete electronics department for the manufacture of radio transmitters, tubes, special receivers, industrial tubes, and electronic devices of every specialized nature, has been organized by the Hygrade-Sylvania Corporation. The new electronics-division factory is at Clifton, N. J., and the department is headed by William J. Barkley, general manager; D. E. Replogle, chief engineer; Victor O. Allen assistant engineer, and a staff of 22 electronics specialists formerly with the DeForest corporation.

Four observatories to catch Arcturus' light, start Fair—The problem of what to do about starting up the Chicago World's Fair June 1, by light from the star Arcturus, captured on a photocell at the Yerkes Observatory, Williams Bay, Wis., in the event of a clouded sky at that point, has been solved by enlisting the co-operation of three other leading American observatories. The first impulse will come from Arcturus through the Harvard Observatory at Cambridge, Mass. and will light one quarter of the Exposition grounds. This star-light left Arcturus forty years ago at the time of the earlier Chicago World's Fair.

R.M.A. at Chicago, June 6.—Industry stabilization and promotion will be the chief topics before the Radio Manufacturers Association, meeting at the Hotel Stevens, Chicago, June 6. The entire membership is being asked to send two or more representatives to the annual business meeting of the Association and its four groups comprising set manufacturers, tube makers, accessory makers, and sound-equipment manufacturers. On June 5, the last meeting of the present board will be held. Fred Williams, president, will preside at the convention sessions, and Paul B. Klugh of Chicago, will have charge of arrangements for the dinner to be held the evening of June 6.

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INFRA-RED "FOG-EYE" TO DETECT ICE-BERGS

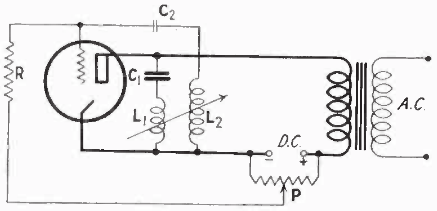
Following a nationwide broadcast over the Columbia network, April 17, the infra-red fog-eye developed by Commander Paul H. Macneil of Huntington, Long Island, N. Y., was demonstrated on the Furness liner "Queen of Bermuda" with the aid of British destroyers. A sensitive thermo-pile has its output amplified so that it is sensitive to one fifty-thousandth of a degree Centigrade. Distant ice-bergs, the hot gases from ships' stacks, and exhausts from air-planes can be detected through fog, in the dark.

REVIEW OF ELECTRONIC LITERATURE

HERE AND ABROAD

A single tube invertor

[H. J. Reich, University of Illinois] A feed-back circuit L_2C_2R is added to the thyratron FG-67 for the automatic transformation of d.c. into a.c., so that when the tube becomes conducting and the condenser C_1 discharges through the tube and the primary of the output transformer, a high voltage is induced in L_2, which is preferably an air core coil, and the condenser C_2 and the grid acquire a strong negative charge, which prevents the breakdown of the tube when the plate is once more charged up through the condenser C. The charge on the grid leaks off in the course of time through the grid resistor R, which, therefore, together with C, the turn ratio of the feed-back transformer L/L_2 and the degree of coupling, determines the number of cycles. The wave form is greatly improved by the addition of a 0.4 h. air core inductor in series with the output transformer primary. The feed-back arrangement can be replaced by an auxiliary rectifier inserted between L_2 and the negative of the supply, a small internal or external auxiliary electrode being satisfactory.—*Review Scient. Instr.* 4:147-152. 1933.



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The new net of German high-power stations

[A. Semm] The net for covering the 171,000 sq.mi. (twice the size of Idaho) comprises nine stations, of which the Berlin and Hamburg transmitter are not entirely completed. They have a power, unmodulated, of 60 kw., and are capable of 70 per cent straight line modulation; only the Leipzig sender has 100 kw. They are located about 10 miles from the nearest town, in places where ground water is found a few m. below the surface. The high-voltage generators, on vibration absorbing supports, are placed in the basement, and are moreover separated from the transmitter room proper by the amplifier and test room. All towers are of pitchpine to reduce losses, and the emitter is 100 to 200 yd. from the antenna. Four stations have a narrow, vertical fish-net antenna of 100 m. height; Breslau has a straight bronze rope, held straight in the interior of the 140 m. high antenna tower and crowned by an octogon of 10.6 m. diameter, giving a current node near the top and throwing more energy along the ground. Four of the stations use 150 kw. tubes; Berlin and Hamburg indirectly-heated 300 kw. tubes, the incandescent cathode proper being made of columbium. The newer stations have or will get grid-controlled rectifiers so as to dispense with the induction transformer for voltage regulation.—*Zeits. Ver. d. Ing.* 77:257-264. 1933.

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Photoelectric pyrometer and spot welding

[G. Mueller and H. J. Zetzmann, Institute of Technology, Berlin.] In spot welding copper the welding times are of the order of 1/25 to 1/50 sec., much too short for measuring the temperatures by the ordinary optical or radiation pyrometers. By letting the radiation from the material to be welded fall upon a caesium phototube with vibration galvanometer followed by an amplifier tube, the change of the temperature from 600 deg. C. to 1,000 deg. C. during the welding process can be ascertained. Filters limit the radiation received to a narrow band in the red. As the currents in the cell are of the order of one μa., careful insulation is required in the entire phototube circuit (amber or quartz). A relay has been added to the welding equipment which stops the machine whenever a certain maximum temperature is exceeded. The indications of the cell can be changed to true temperature by applying Wien's law.—*Zeitz. Techn. Phys. 14:90-94, 1933.*

◆

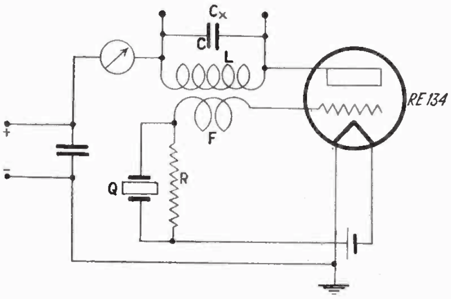
The excitation of light in sodium vapor

[G. Haft.] While five-volt electrons are just able to excite the yellow sodium line, which is being used in the new high way lighting sources (*Electronics*, August 1932) they excite light in only a small number of collisions with sodium atoms; but the number increases rapidly to one-fifth when the speed of the electron is raised to between 10 and 12 volts; beyond this range it decreases to remain at about one-third of the maximum between 150 and 200 volts.

The yield seems to be much larger than in the case of helium and mercury, and the drop in yield with increasing velocity not by far as in other cases.—*Phys. Zeits.* 34:287-288. 1933.

A new method for measuring capacities at high frequencies

[Th. W. Schmidt, Silicates Research Laboratory, Berlin.] The method is based upon the property of a tube with tuned grid and tuned plate circuit and feed back coil F that the oscillations start and stop very suddenly, with a corresponding sudden change in the d.c. plate current when grid and plate circuit are gradually adjusted to resonance. Measurements were carried out with quartz-controlled oscillators, the quartz plates giving resonance at 46 m., 100m., 189 and 340 m. A change of 1/10 $\mu\mu$f produces a change of about 14 ma. in the plate d.c. When the plate voltage was allowed to drop to one-half, the result changed by only 0.3 per cent, a change in heating current of 10 per cent gave an error of 0.6 per cent. (Practically the same circuit can be used for measuring inductances). When very small unknown capacities are added to the tuned plate circuit, the values may be deduced from the change in plate current.—*Hochfr. Techn & El. Ak.* 41: 96-98. 1933.



◆

German specifications for radio receivers

The Final Draft of the specifications coming into force Jan. 1, 1934, provide that when the receiver has connections for various supply voltages they must be so arranged that switching from one value to the other can be accomplished only by means of tools. The receiver must bear the manufacturer's nameplate indicating the operating voltage. When power packs are used, they must be screwed to the receiver proper. With 20 deg. C. in the room, no part of the housing shall reach 50 deg. The insulation between the cable and any accessible metallic portion of the receiver, tested by applying 1,500 volt d.c. shalt exceed 2 meg., or when testing with the a.c. supply, the current shall not exceed one mil. After this test, 1,500 volts d.c. are applied for one minute.—*El. Techn. Zeits.* 54: 315-318. 1933.

The effect of X-rays on barrier-layer cells

[K. Scharf and O. Weinbaum] When 80-kv. X-rays fall upon copper-cuprous oxide or selenium cells, the photelectric current and voltage produced are of the same order as when the cells are exposed to light. With X-rays of such a wave-length that the intensity is halved after passage through 0.03mm. copper, the initial intensity being equal to one roentgen per sec., the current was about 0.07 μa with a front wall cell and 0.25 μa per sq.cm. with a selenium cell when the resistance in the outer circuit amounted to 300 ohms. Cells from different manufacturers differ in response.

Similar work is also reported by P. R. Gleason, Colgate University, who used 200 kv. electrons and hopes to be able to develop the cells as a convenient means for measuring X-ray intensities. —*Zeits. f. Physik.* 80: 465-482. 1933.

✦

The fight against man-made static

(1) *Rundfunk Stoerbefreiung, by H. Keller. Published by Deutsch-liter, Institut, Berlin, 1932. 80 pages, 88 fig., 50 cents.*

(2) *Rundfunk Entstoerungstechnik, by F. Conrad. Published by Weidmannsche Buchhandlung, Berlin, 1932. 56 pages, 47 fig., 30 cents.*

(3) *Rundfunk Stoerungsfrei, by E. Schwandt. Published by Hachmeister und Thal, Leipzig, 1932. 74 pages, 54 fig., 20 cents.*

The fact that three booklets on this subject appeared at the same time, one of them, though perhaps not the best one, sponsored by the German Radio Engineering Society, indicates how serious the question is despite the fact giant stations are the fashion in Europe.

✦

Storage batteries 1930-1933

[L. Jumau] The article deals with recent French patents on the preparation of the lead plates (16 patents), the deposition of the active material (13 patents) by centrifugal and chemical methods, the electrolyte (14 patents), accessories (32 patents, mainly on cases, stoppers, separators, connectors protected according to one patent by a paste containing 1,000 grams of sodium carbonate and 1,200 grams of automobile oil), methods of mounting (37 patents, to prevent spilling, etc.), storage batteries other than lead batteries (40 patents relating to sulphuric acid and copper, zinc, cadmium, lead-zinc, alkaline batteries), charging (34 patents, including a switch cutting off the secondary together with the primary when radio batteries are charged through a copper oxide rectifier).

In addition, an article by C. Fery (*Revue gen. del' Electr.* 33:313-318, 1933) describes how by having the negative plate surrounded by hydrogen at all times while leaving the positive plate in contact with air, sulfation is greatly reduced.—*Revue gen. El.* 33:339-352. 377-392. 413-424. 1933.

✦

Electron emission from oxide-coated filaments

[[1]M. Benjamin and H. P. Rooksby, Research Laboratory, General Electric Co., Wembley; [2]W. G. Burgers, Philips Research Laboratory, Eindhoven.] Flashing at high temperatures, or exposure to air at ordinary running temperature, is liable permanently to spoil oxide-coated filaments. Nickel in the form of wires 0.044 mm. diameter, cleaned and annealed in hydrogen at 700 deg. C., was coated by passing it through a series of baths containing a suspension of strontium and barium carbonates and sintered at 700 deg. C. in an atmosphere of carbon dioxide (coating weight 0.25mgm. per 20 cm. length of wire). X-ray analysis of the structure shows that the loss of emission is associated with a loss of barium oxide in preference to strontium oxide. This was also shown by work carried out at the Eindhoven Laboratory. The filament may be regenerated if, instead of flashing, the surface layer (rich in strontium oxide) is sputtered off by passing a discharge through the tube.—[1]*Phil. Mag. J. of Science* 15:810-829. 1933. [2]*Zeits f. Physik* 80: 352-360. 1933.

✦

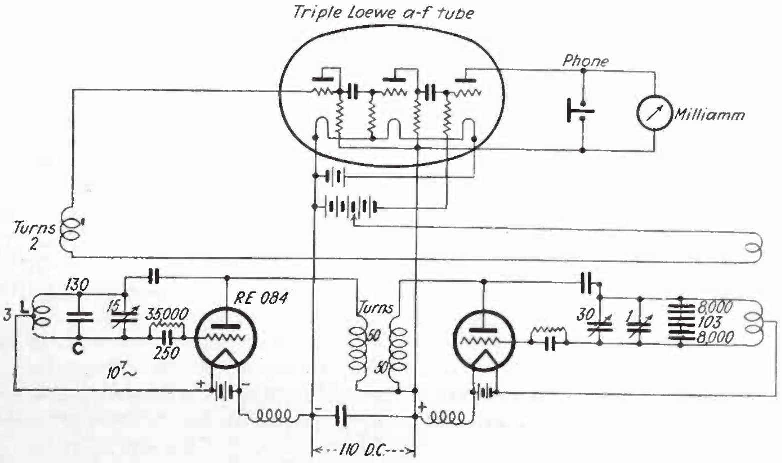
Wehnelt cylinder in relation to electron direction

[F. Hamacher, Aachen Institute of Technology] The electrons are received upon a luminescent calcium tungstate plate at 12 cm. from the straight or bent tungsten single crystal wire of 13 mm. length and 0.2 mm. diameter. The width of the trace of the electrons upon the screen, 2 mm. at 12 cm. is proportional to the distance from the source. The emission is limited to a narrow region, one-tenth of the length. Above 1,000 volts the electrons leave the wire in a true radial direction, and in order to get a strong sharp pencil of charges through a diaphragm, the direction of the electrons must be changed by surrounding the V-shaped filament with a negatively charged cylinder. When the distance from the tip of the filament to the nearest edge of the cylinder is varied, while the diameter of the trace upon the screen is kept constant by adjusting the cylinder voltage, the current density in the trace reaches a sharp maximum for a certain distance, about 8 mm. in the case described, a point which is useful in the construction of cathode-ray tubes.—*Arch. f. Electrotechn.* 27:47-56. 1933.

✦ ✦ ✦

Electronic device for temperature measurements

[H. Esser and W. Grass, Aachen Institute of Technology.] Vacuum all-metal calorimeters, in which the hot body drops into a metal container to which it gives its heat, are very reliable for measuring the specific heat of solids at high temperatures, but when oxides or carbides are used, delays and losses are considerable. The remedy is to measure the final temperature of the metal container not by means of thermometers or thermopiles, but by its expansion. To this end it is made to form one side of a condenser (103) which is part of the tuning circuit of a beat frequency oscillator. The diameter of a copper cylinder of 8.5 cm. changes by 0.14 millicm. for a degree C., and this change is readily detected in the pitch of the heat frequency when 30 m. waves are used. A change of 3/1,000 degree centigrade produces a loss or an increase of 10 cycles. The calorimeter-condenser is placed between two much larger condensers of 8,000 μμf.—*Archiv f. Eisenhuttenwesen.* 6: 353-357. 1933.

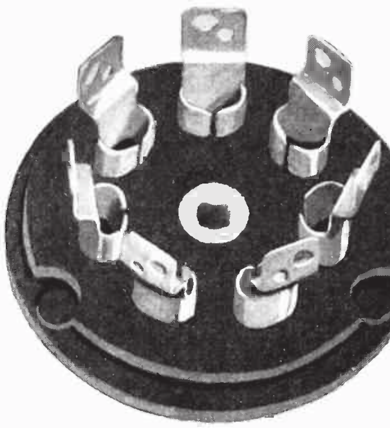


+ NEW PRODUCTS

THE MANUFACTURERS OFFER

Complete radio socket

The Cinch Manufacturing Corporation, 2335 W. Van Buren St., Chicago, Ill., is now making a complete radio socket in one part that does away with the handling of two extra rivets and the use of riveting machines. It is only necessary to punch a hole in chassis, insert socket and a short turn will lock it securely and rigidly in place.



The Cinch socket, to be known as model 44, is available for four, five, six and seven prong tubes. Booklet illustrating the complete line of tube sockets, radio plugs, laminated plugs, binding posts, tip jacks, soldering lugs, mounting strips and metal stampings may be had upon request.—*Electronics, May, 1933.*

✦

Pickup and amplifier for musical instruments

With Headquarters at 111 Fulton St., Grand Rapids, Mich., the Musical Arts Laboratories' system of pickup and amplification for stringed instruments involves the use of a small pickup unit and a specially designed amplifier.

The pickup unit is about the size of a silver dollar, but a trifle thicker. It weighs less than an ounce and is interiorly installed in fretted instruments, and exteriorly and indirectly placed for use with bowed instruments.

It is usable in any fretted instrument and in no way affects the natural tone character and volume of the instrument. When connected with the amplifier, the tone delivery from the amplifier is in addition to the natural tone delivery of the instrument itself. In other words, a fretted instrument with the device installed can be played in exactly the same way and with exactly the same results as heretofore, whether with or without amplification.

Installation in fretted instruments involves no external change in the instrument, except that in the hole where the end button is ordinarily inserted, there is placed a small plug-in receptacle into which the connecting cord is plugged or detached, as instrument is used for amplified playing or without.

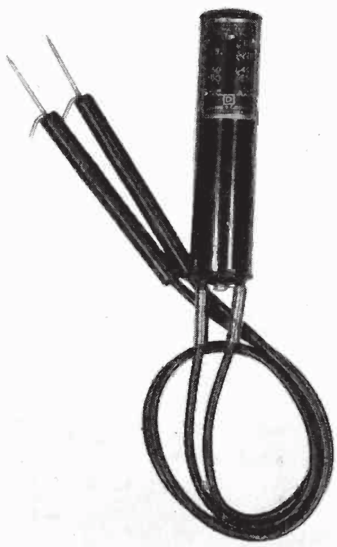
For the violin and viola, the pickup device is installed in a special chin rest with the plug-in cord attachable or detachable. With the cello and double bass, the pickup is installed in a special end pin which is used instead of the regular end pin.

The amplifier cabinet, dimensions 11 in. by 11 in. by $4\frac{1}{2}$ in., contains amplifier and speakers. It is attractively designed and finished, and weighs about 10 lb. A single cord extends from amplifier to instrument and another from amplifier to current connection. Amplifier is usable on any 110-volt current, whether d.c. or a.c. —*Electronics*, May, 1933.

✦

Voltage tester

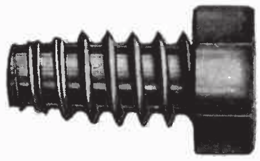
A voltage tester that requires no lamps and registers accurately the voltage as well as indicating whether it is a.c. or d.c. is announced by the Square D Company, Detroit, Mich. The tester is inclosed in a rugged fiber case so that there is no danger to the operator or to the tester.



It is simple to operate, it is claimed; all that is necessary is to place one wire in each side of the circuit and the indicator shows what the voltage is. A.c. voltages are shown by the slight vibration of the indicator.—*Electronics, May, 1933.*

Self-tapping cap screws

After three years' use, at first experimentally and then in regular production, in some of the largest metal-working plants in the country, these Hex-head-hardened self-tapping cap screws now take their place as a member of the Parker-Kalon group of time- and labor-saving fastening devices. Like other types of Parker-Kalon self-tapping screws, these cap screws eliminate tapping; they form their own thread in the material . . . as they are turned in. The elimination of this troublesome and costly operation results in large savings and other advantages besides.



The screws are extensively used for making fastenings to sheet metal from 24 gauge to 10 gauge; to steel plate and structural shapes up to $\frac{1}{2}$ in. thick, and to solid sections of brass, bronze, aluminum and die castings, slate, transite board, ebony asbestos, etc.

They are made in a complete range of sizes from No. 6 to $\frac{1}{2}$-inch diameter. The Parker-Kalon Corporation, 200 Varick St., New York City, offers to send free, test samples to any design engineer, production official or plant executive, together with complete engineering information. — *Electronics, May, 1933.*

✦

Resistor heating material

Driver-Harris Company, Harrison, N. J., announces a new series of Nichrome alloys, to be known as "Nichrome V," the latest step in the development of nickel-chromium alloys.

Twenty-five years of experience in dealing with problems of heat resistance equips the company's technical staff to meet the requirements for longer life, quicker heating and greater overload capacity. This growing demand for increased speed, high temperatures and longer life has led to the introduction of "Nichrome V."

The performance of "Nichrome V" on the life-test board has far exceeded the expectations of the engineers, inasmuch as it was substantially more than that of any material heretofore furnished.—*Electronics, May, 1933.*

Time-delay relays

The Ward Leonard Electric Company, Mount Vernon, N. Y., is marketing a new motor-driven time-delay relay designed to produce a definite time interval between two different operations. The relay consists of a small constant-speed driving motor, a gear train, a tripping arm and a magnetic operated clutch between the trip arm and gear train. The time interval may be readily adjusted by changing the arc of travel of the trip arm. Various time ranges are provided by standard and special gearing. Standard gearing affords three time ranges: 4 to 60 seconds, 20 seconds to 5 minutes and 2 minutes to 25 minutes.

Electric Motor Driven Time Delay Relay

The total maximum input is 5 watts at 110 or 220 volts, 60 cycles, contact capacity 2 amperes a.c. or 0.5 amperes d.c. The size is approximately 3⅜ in. by 3½ in. by 3 in. deep.—*Electronics, May, 1933.*

✦

Rubber rule

Halloway Kilborn of the Kilborn & Bishop Company, 196 Chapel St., New Haven, Conn., manufacturers of tools, has developed a rubber rule which has a number of applications for measuring objects, counting, and solving various mathematical equations. A strip of highly-elastic rubber is marked off into divisions, and when stretched, has the property that all its divisions are equally expanded. By applying a given division to a known unit, then the total expanded rule applies proportionately to the material to be counted or measured. Thus the rubber-rule can be used as a multiplier or divider. In other forms it can also be used to derive logarithms, solve equations, and work out mathematical problems. — *Electronics, May, 1933.*

✦

Cellophane indoor aerial

A novelty in indoor aerials is Cello ribbon antenna made by Freydberg Brothers, 11 W. 19th St., New York City. Instead of the usual unsightly wire, this new type antenna is a thin flat ribbon covered with colored cellophane. It is said to secure better reception than other types of indoor antenna because of its large surface area and its cellophane insulation.

A further advantage lies in the decorative quality of the cellophane covering itself. This comes in a variety of colors and can be harmoniously adapted to any decorative color scheme.

Cello ribbon antenna is extremely flexible and may be fastened around moldings or baseboards without difficulty.—*Electronics, May, 1933.*

✦

Fitted glass filters

Utilizing the properties of metallic mercury and of fritted glass filters, a new valve developed for introducing gases at low pressures into highly evacuated systems, avoids the uncertainty and inconvenience of plug cocks and other similar valving arrangements. Fritted glass filters with very fine pores will not permit the passage of liquid mercury even at high pressure differences on account of the high surface tension of the mercury, but they are highly permeable to gases and offer very low resistances to gas flow. In addition to this important property, such filters, being made entirely of chemically resistant glass, are not wetted by mercury so that when two filter faces are brought together the mercury between them is squeezed away, leaving a free passage for gas from one to the other. These facts have been applied to the accurately regulated introduction of low pressure gases into high vacua, as required particularly in the radio and incandescent lamp industries, in the apparatus distributed by the Fish-Schurman Corporation, 230 E. 45th St., New York City.—*Electronics, May, 1933.*

✦

Turntable adapter

The "Diskadapt" is the name of a new development for making old turntables instantly adaptable to new or old speed. It plays the new long-playing records at 33⅓ r.p.m. or, by the simple pressing of a lever, the regular old-type records at 78 r.p.m. Diskadapt fits all makes of electric or spring-driven phonographs. Anyone can install it in a few minutes. A simple, rugged mechanism is concealed beneath its smartly finished disk. Diskadapt is made, from raw material to finished product, in the factory of the New Era Specialties Corporation, 21 Spruce St., New York City.—*Electronics, May, 1933.*

Relay for radio circuits

The Signal Engineering Company, 142 W. 14th St., New York City, has developed a new junior type C-7 relay which has many radio circuit applications, owing to the unique feature of the dual contacts, making it available for two-circuit control work without the use of pigtails on the arms.

This C-7 relay is also equipped with condenser and resistor mounted on the bakelite base of the unit, giving a reading of 9 milliamperes through the control circuit, while the contacts of the relay will handle loads up to 15 amperes.

This combination makes an ideal device for crystal oven temperature control in conjunction with the sensitive adjustable mercury-type thermal temperature control device for such crystal ovens, and the 9 milliampere current flow is so slight that no harm is done to the sensitive column of mercury used in such critical temperature control devices. The use of the condenser in the coil circuit of the relay practically eliminates all trace of sparking, which is harmful to sensitive instruments.—*Electronics, May, 1933.*

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Manufacturers' bulletins and catalogues

Resistance units—Ohmite vitreous-enameled and cement-coated resistors are featured in the April Ohmite News, issued by Ohmite Manufacturing Company, 636 North Albany Ave., Chicago, Ill.

Photo-cell alarms—"Intellect-A Ray" photo-cell alarm and industrial units are described and illustrated in new circulars issued by the Intellect-A-Ray Corporation, Singer Building, Pasadena, Calif.

Direct-current amplifier—The amplifier unit developed in connection with the Macneil all-weather sextant, an amplifier which has many other applications, is described in a special circular just issued by Allen DuMont Laboratories, Upper Montclair, N. J.

Sound-on-film projectors and cameras—Recording cameras, amplifiers, projectors, sound-heads, photo-cell kits, and tubes are described in new bulletin of Herman A. DeVry, In., 1111 Center Street, Chicago, Ill.

Radio contact pins—The Bead Chain Manufacturing Company, Bridgeport, Conn., announces having granted a license for the manufacture of radio contact pins, also molding them into radio tube-bases, to the Waterbury Brass Goods Corporation, Waterbury, Conn.

Electro-dynamic loud-speakers—All Jensen electro-dynamic speakers are described in a new circular issued by the Jensen Radio Manufacturing Company, 6601 South Laramie Avenue, Chicago, Ill. Special features include the new Orthodynamic model, and the new Model T-3 in the small-speaker class.

Wire-wound fixed resistors—Candohm resistor units are described with complete specifications in the new Candohm technical catalog 4-1-33, issued by the Muter Company, 1255 South Michigan Avenue, Chicago, Ill.

Selenium cells—The Acousto-Lite cell for burglar alarm, light-beam control, chemical density measurements, sound pick-up, etc., is described in a new bulletin issued by The Acousto-Lite Corporation, 2908 South Vermont Avenue, Los Angeles, Calif.

Condensers—Tubular condensers, by-pass condensers, and uncased condensers are described in a circular giving working voltages and other specifications, issued by the Cosmic Products Corporation, 2157 Prospect Avenue, New York City.

U. S. PATENTS

IN THE FIELD OF ELECTRONICS

Photo Cell Application

Color matcher. Method of matching the color of a luminous body to that of a body of known color characteristics by alternately projecting upon the photocell light rays from the opposite halves of the spectrum of the luminous body of known color which will produce equal electrical current in photocell circuits; substituting for the luminous body the body whose color is to be matched and altering the color of the body until the light ray thus projected produces in the photo cell circuit two equal currents. C. H. Sharp, White Plains, N. Y. Filed Sept. 6, 1929. No. 1,898,219.

Oscillation generators. Patent Nos. 1,894,636 and 1,894,637 to G. B. Scheibell assigned to Wired Radio, Inc., on methods for producing oscillation, one using a photocell and an electrostatic light cell and the other using a cathode ray tube.

Picture transmission system. Use of a photocell having an anode, cathode and control electrode. C. A. Culver assigned to Wired Radio, filed May 1, 1929. No. 1,898,080.

Television system. Projecting an image upon a photoelectric screen, then interrupting the light beam forming the image and scanning the screen. F. C. P. Henroteau, Ottawa, Canada. No. 1,903,113. Also No. 1,903,112.

Synchronizing system. Production at the transmitting station of a continuous cycle of signals of predetermined duration in order and strength variable in accordance with areas of an image to be transmitted. C. F. Jenkins assigned to Jenkins Laboratories, Inc. Reissue No. 18,783.

Radio Circuits

Superheterodyne. Method of maintaining a constant frequency difference between the locally generated and signal representing oscillations. V. C. MacNabb assigned to Atwater Kent Mfg. Co. Filed Nov. 5, 1931. No. 1,896,825.

Directional system. An automatic steering device for dirigible craft comprising the gyroscope and a radio responsive means for controlling the torque about the lower frontal axis of the gyroscope. E. A. Sperry, Jr. and B. A. Wittkuhns assigned to Sperry Gyroscope Company. No. 1,896,805.

Audio amplifier. Push-pull amplifier whose secondary is resonant to a frequency near the upper end of the audio frequency range and whose primary circuit is resonant to a frequency near the lower end of the range. A. H. Grebe, Hollis, N. Y. Filed Dec, 24, 1930. No. 1,895,792.

Rejector system. In a superheterodyne circuit to eliminate undesired signal frequencies, differing from the desired signal frequencies by slight intermediate frequencies. V. C. MacNabb assigned to Atwater Kent Mfg. Co. Filed July 23, 1930. No. 1,895,809.

Amplifying system. An oscillatory tube amplifier with feed back for preventing oscillation over the range of frequencies with which the amplifier is to work and additional feed back to prevent oscillation at higher frequencies. K. W. Jarvis, assigned to W. E. & M. Co. Filed July 17, 1926. No. 1,899,758.

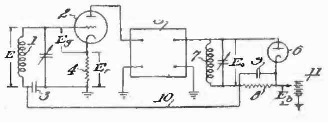
Corkscrew radiation. Method of rotating the plane of polarization of a directly emitted wave to obtain directive corkscrew radiation and wobbling the directivity of the radiation at a frequency lower than the rotative frequency. N. E. Lindenblad, assigned to R.C.A. Filed Aug. 17, 1927. No. 1,898,058.

Amplification, Detection, Etc.

Current source. Apparatus for supplying the filaments of thermionic tubes having different amplification factors with a source of pulsating direct current; a means is provided for connecting the filament of the high amplification tubes in series through an inductance and resistance and for connecting the remaining tube filaments through the resistance. Rudolf Rechnitzer assigned to Telefunken Gesellschaft, Berlin, Germany. Filed Nov. 14, 1929. No. 1,902,894.

Negative inductance. An automatic device having reactance characteristics of opposite signs to that of an inductance, such reactance varying in direct proportion to frequency in accordance with the formula of reactance equals $-2\pi fL$, f is the frequency and L is a constant. M. M. Dolmage, Washington, D. C. Filed October 4, 1928. No. 1,903,610.

Audion amplifier. Method of automatic volume control which comprises impressing upon the amplifier input circuit two discrete d-c potentials which vary automatically and according to different functions of the magnitude of the incoming electrical wave. One of these potentials is effective for weak signals and the other for strong signals. A. W. Barber, Boonton, N. J. Filed Feb. 12, 1931. No. 1,903,542.

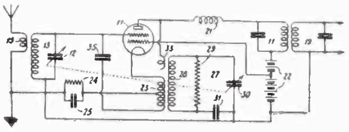


Electric regulator. An electric machine having a stator and a rotor, a tuned circuit responsive to changes in a characteristic of the machine and a vacuum-tube regulator responsive to said circuit. H. M. Stoller assigned to W. E. Co. Filed June 11, 1919. No. 1,895,498.

Electrical control system. For maintaining a predetermined speed ratio between members of a system having several rotatable members by using light-sensitive means and by moving the light-sensitive means in accordance with the speed of one of the members. John Hammond, Jr., assigned to G. E. Co., No. 1,895,925.

Synchronizing system. Apparatus for determining and equalizing differences in the positions of two shafts located at a distance apart comprising a network, a rotary transformer, push-pull amplifier tubes, etc. Johannes Vopel and Rudolph Oetker, Berlin, Germany. No. 1,895,240.

Oscillator. An oscillator-modulator arrangement using a tube with two grids and a method for neutralizing the grid to cathode capacity of the tube relative to the oscillation frequency input whereby the presence of a tuned input circuit will not affect the oscillation frequency voltage. V. E. Whitman, New York, assigned to Hazeltine Corp. Filed April 9, 1932. No. 1,893,813.



Power applications, etc.

Weak current indicator. Device for switching considerable current by extremely weak current comprising gas discharge tubes with main electrodes and an auxiliary electrode. The energy supply connected to the main electrode is ordinarily too weak to produce ionization and an auxiliary potential upon the auxiliary electrode of very low potential starts the discharge. R. H. H. Geffckin and R. H. Richter, Leipzig, Germany. Assigned to Radio Patents Corp. Filed Nov. 12, 1924. No. 1,898,046.

Reactance-controlled relay. A self-modulating, high-frequency oscillator with a relay in the plate circuit vibrating at the frequency corresponding to the modulation frequency. P. S. Edwards and C. D. Barbulesco, Dayton, Ohio. Filed Oct. 2, 1929. No. 1,898,432.

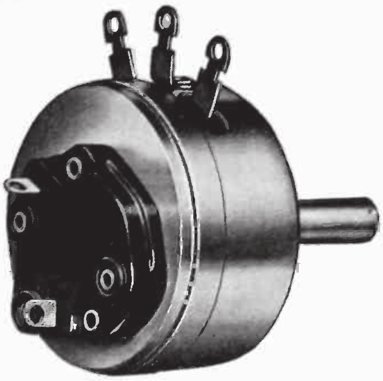
A-C generator. Circuit using a vapor electric valve and a condenser charged through a resistance and discharging from cathode to grid. C. S. Franklin and D. A. Cutler, assigned to G. E. Co. Filed Jan. 28, 1931. No. 1,898,827.

Modulation system. Method of modulating a gaseous cold-cathode tube. August Hund, assigned to Wired Radio, Inc. Filed Nov. 2, 1931. No. 1,898,486.

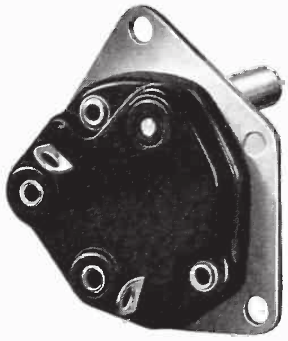
A-C generator. Use of the discharging condenser for generating a periodic current of approximately sine wave form. B. D. Bedford, assigned to G. E. Co. Filed Jan. 28, 1931. Renewed Sept. 10, 1932. No. 1,898,932.

Glow lamp circuit. Method of connecting a glow lamp to a two-rectifier circuit. M. J. Druyvesteyn, Holland, assigned to R.C.A. Filed Dec. 21, 1929. No. 1,899,021.

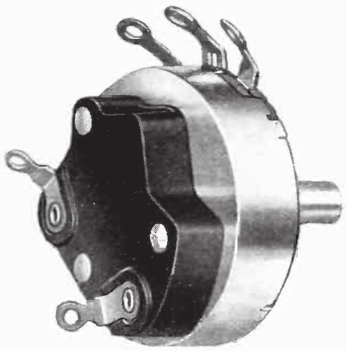
Photocell amplifier circuit. Method of connecting the output of a light-sensitive cell to a triode amplifier tube. T. H. Nakken, assigned to Nakken Patents Corp. Filed May 21, 1929. No. 1,899,712.



No. T20 Series, with switch.

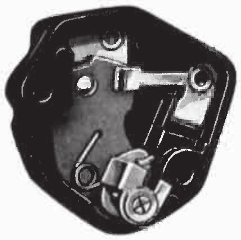


No. 11 Switch, for panel mounting
No. T, for unit mounting.



No. T70 Series, with switch.

Why not discuss your Volume and Tone Control problems with us?



Lowest Operating Torque and Contact Resistance

A lot to claim — a lot to deliver — yet our No. 11 *does* have these outstanding features. Also has smallest knob movement, positive kickoff, double bearing "cold" cam, and a lot of other advantages —plus Underwriter's Laboratories' Approval for 3 A, 125 V., 1.5 A, 250 V, AC or DC. Write for samples. You'll find our No. 11 even better than we claim!

IT is quite possible that we can help you solve some of those Volume and Tone Control problems of yours . . . We've done it for a number of other set manufacturers . . . Some of them have been just a little surprised—perhaps *astonished* would be a better word—to learn just how thoroughgoing and painstaking we are . . . A number of our set manufacturer friends have told us we helped them greatly in this particular phase of their production. And we'd like to help you, too!

No small share of our success in the development and manufacture of superfine wire wound and carbon element type variable resistors is due to our having constantly maintained a 100% Engineering and Research Department. And when we say 100% we mean just that! It is on its toes every hour of the working day—and on numerous occasions far into the night—to help folks like you obtain properly designed volume and tone controls . . . incidentally, our Engineering Department is second to none in the entire industry.

We want to help. How can we do so? If you will write us fully, sending specifications or chassis, we'll submit samples . . . efficiently engineered . . . promptly . . . and with no obligation whatever! May we hope to serve you soon?

CHICAGO TELEPHONE SUPPLY CO.

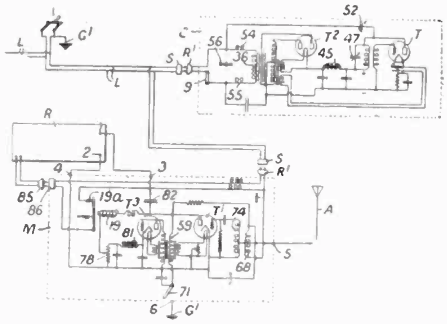
HERBERT H. FROST, Inc.
SALES DIVISION
General Offices ELKHART, INDIANA *and Plant*

BRITISH PATENTS

IN THE FIELD OF ELECTRONICS

Radio Circuits

Remote control system. A superheterodyne type of receiver in which the local oscillator is distinct from the receiver proper and may be used at any point in the dwelling remote from the receiver itself by using the power lines in the house to transmit the local oscillator output to the mixing tube in the receiver. Thus the portable oscillator can be plugged into a receptacle at any point in the house and can, from this point, control the receiver. At the receiver the mixing tube with its associated power rectifier is left permanently connected to the power lines so that it can be energized by the remote control tube. When the output of the remote control oscillator is fed into the line, it changes the plate current of the mixing tube and this change will operate a relay to turn the power into the set proper. A. S. Blatterman, 1304 Wannamassa Drive, Asbury Park, N. J. No. 383,189.



Railway signalling. Apparatus for transmitting to and receiving from the rails electro magnetic oscillation whereby braking and warning signals are given when two trains approach too closely. A. Modrach Belgrade. No. 384,982.

Super-regenerative receiver. The quenching frequency is arranged to render the tube alternately operative. The signal is applied to the tube in push-pull while the tubes are each back coupled in opposite sense. Walter van Roberts, assigned to Marconi Co. No. 385,525.

Automatic volume control. Use of dry surface contact type of detector for providing automatic volume control in a radio receiver. A. V. Tomlinson, Union Switch & Signal Co. No. 385,619.

Detector. Uses dry surface contact type of detector with sufficiently high capacity to act as a storage condenser, when the applied potential is in the high resistance direction, and the rectified signal is applied to the grid of a thermionic tube or other load. A. V. Tomlinson, Union Switch & Signal Co. No. 385,998. See also No. 385,997; same inventor and assignee.

Infra-red signalling. Method of signalling between ships or airplanes or between either of these and land stations by the use of infra-red, heat or ultrashort wireless rays. T. M. Hawker. No. 384,325.

Super-regenerator. A receiver designed especially for compactness and portability. Tapped input and output inductances are coupled together and the input is tuned by variable condenser in series with a variable resistance. The tube is designed to operate with three-volt heating voltage and 4½ volts anode supply. W. V. B. Roberts, Marconi Co. No. 382,881.

Variable-mu tubes. Method of varying the grid turns so that various portions of the grid structure have different orders of control over the space current. Boonton Research Corp. No. 382,945.

High-frequency oscillators. Use of a high frequency field for cracking heavy oils comprising a transformer, a condenser and a quenched or rotary gap. Aktis, Akt-Ges., Switzerland. No. 383,384.

Gaseous amplifier. A valve generator or amplifier having an auxiliary discharge serving as an electron source with means for feeding back energy from the output circuit into the auxiliary discharge circuit. Telefunken. No. 383,807.

Apparatus for the blind. A method of reproducing printed matter in a form suitable for touch reading by blind persons by scanning sections of the matter with light rays and forming indented characters. R. E. Naumburg, Cambridge, Mass. No. 383,835.

Superheterodyne circuits. Method of eliminating interference such as the image frequency in a superheterodyne receiver. J. K. Johnson, Hazeltine Corp. No. 384,544.

FIG. 1

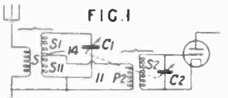


FIG. 3.

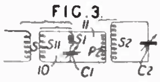


FIG. 7.

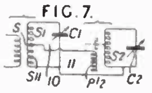


FIG. 4

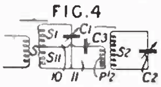
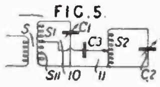


FIG. 5.



Coupling circuit. A fixed capacity shunted by an inductance is coupled to another shunt circuit with variable capacity by means of a fixed condenser. The primary circuit is tuned to a fixed frequency below the lowest frequency to which the second circuit is to be tuned. Substantially uniform overall transmission characteristics may be obtained. D. E. Harnett, assigned to Hazeltine. No. 383,987.

Frequency modulation. In a frequency modulated transmitter accidental amplitude modulation is neutralized by applying intentional amplitude modulation of opposite phase. W. Albersheim, Marconi Co. No. 383,412.

Stable oscillator. The frequency of an oscillator is kept constant despite changes in anode voltage by providing an auxiliary anode and applying to it a voltage proportional to that of the main anode whereby any frequency change due to change of anode voltages is counterbalanced by a frequency change of equal amount but of opposite phase due to alteration of the auxiliary anode voltage. J. B. Dow, assigned to Wired Radio, Inc. No. 383,981.

Discharge tube. A cathode for a thermionic discharge tube is provided with an emissive layer comprising barium or another metal of the alkali or alkaline earth series in the free state and a small amount of one or more alkali or alkaline earth metal compounds having, at the working temperature, a higher electrical conductivity than the monoxide of the emissive metal present in the free state. Barium sulphide and barium cyanide are specified as compounds suitable for use with barium and the examples given relate to the use of barium sulphide with or without other compounds as follows: (1) Barium sulphide is applied to the cathode and barium is atomized upon it in known manner. (2) A minute quantity of sulphur vapor is introduced into the tube either prior to or immediately after atomizing barium in excess on to the cathode. (3) Barium sulphate is applied to the cathode and barium in excess is atomized within the tube so that some of it reacts with the barium sulphate to form barium sulphide and barium monoxide. (4) A tungsten filament is coated with potassium bisulphate by passing it through the molten compound at 270-300° C. and fitted in the tube, the bisulphate is converted into the normal sulphate by heating the filament during the pumping operation, and barium in excess is atomized on to the cathode from a mixture of barium oxide and aluminum, heated at some part of the tube remote from the cathode, so that some of the barium reacts with the potassium sulphate to produce a mixture of the oxides and sulphides of potassium and barium. (5) A small amount of barium is atomized on to the cathode, a small amount of hydrogen sulphide is introduced into the tube, the excess of hydrogen sulphide and the hydrogen formed are pumped off, the tube is sealed and barium in excess is vaporized and deposited on the cathode in known manner; in this case the electrodes other than the cathode are preferably of a metal, such as molybdenum or tungsten, not readily attacked by hydrogen sulphide. (6) Sulphur dioxide is used in place of the hydrogen sulphide in (5) with the advantage that the electrodes may be of other metals such as nickel; in this case the reaction of sulphur dioxide with small quantities of barium oxide present produces barium sulphide and barium sulphate and the latter reacts with some of the metallic barium as in (3). Calcium strontium and potassium are also specified for use as emissive metals in place of barium. D. S. Loewe and O. Emersleben, Berlin. No. 380,835.

electronics

radio, sound, communications and industrial applications of electron tubes ◆ ◆ ◆ design, engineering, manufacture

Electron tubes at the Chicago World's Fair

◆

Trends in radio design and manufacturing

◆

The Ignitron—a new rectifier

◆

Modern reflex circuits

◆

Landing of aircraft in fog by radio

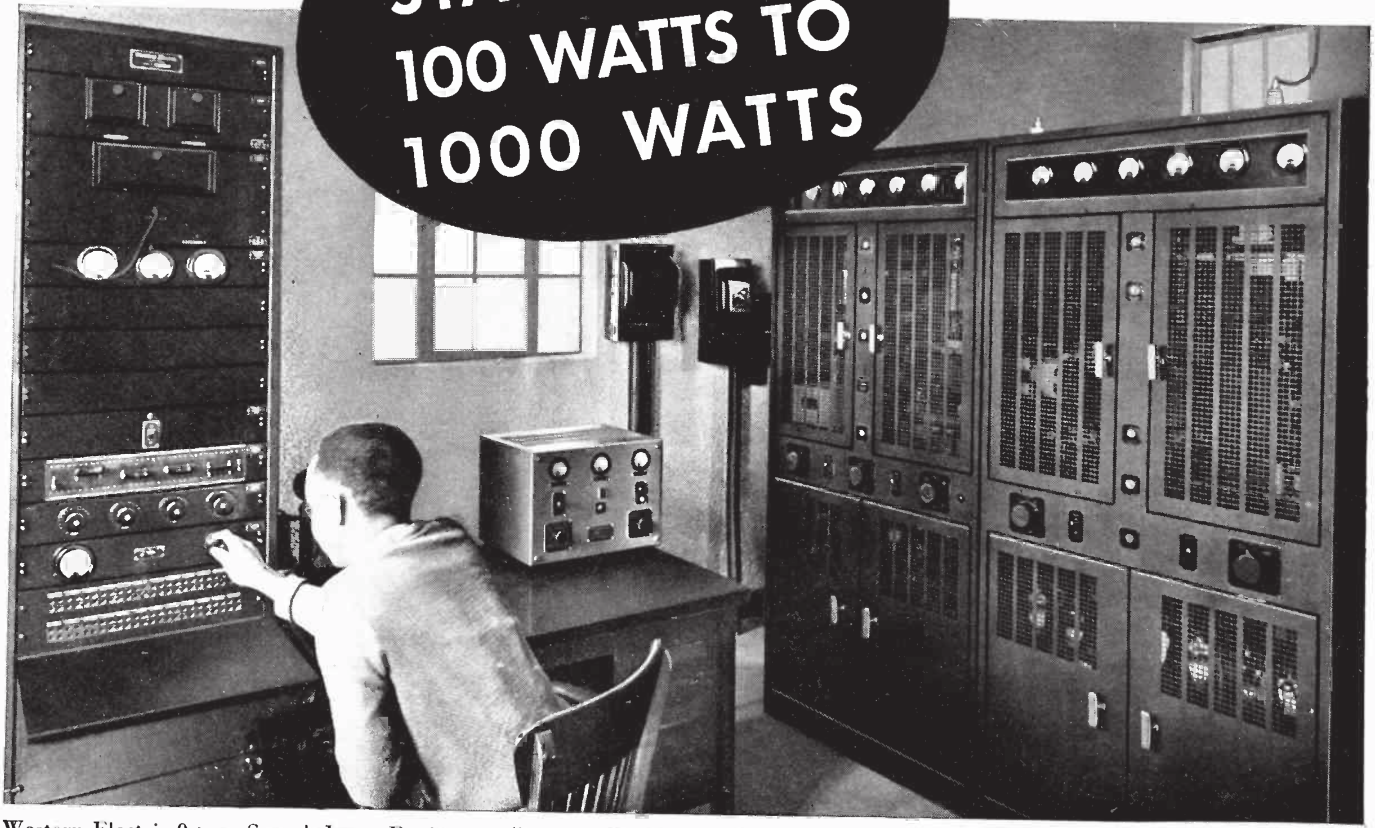
Neon lighting of 176-ft. tower of Hall of Science, Chicago

McGRAW-HILL PUBLISHING COMPANY, INC.

Price 35 Cents

JUNE, 1933

CHOSEN BY STATIONS OF 100 WATTS TO 1000 WATTS



Western Electric 9 type Speech Input Equipment (left), 1A Frequency Monitoring Unit (on desk), 12A Transmitter and 71A Amplifier (right) as installed in Station KFAC (1000 watts) at Los Angeles.

...for quality, compactness, efficiency and economy!

Some 30 stations*—ranging in power output from 100 to 1000 watts—are now using Western Electric 12A Radio Broadcasting Transmitters. For power higher than 100 watts, the 12A is used as driver for the 71A Amplifier. This combination delivers 250 or 500 or 1000 watts depending upon tubes used in the output stage.

Notable features are: unusual frequency stability—fidelity of transmission—100% grid bias modulation. No rotating machinery—all transformers, rectifiers and control apparatus built in—apparatus fully enclosed, all high voltages eliminated when any door is open. All tubes radiation cooled.

Designed for easy installation, this equipment is extremely compact—each cabinet requires only 25″ x 36″ floor space. Connections are made directly to power supply mains. Push button control simplifies operation.

When A. C. operated single rack 9 type Speech Input Equipment is added—of which the Moving Coil Microphone is a part—no more modern or efficient broadcasting installation for its power is available.

GRAYBAR ELECTRIC CO. E 6-33
Graybar Building, New York, N. Y.
Gentlemen: Please send me full information on the Western Electric 12A Radio Transmitter, 71A Amplifier, and 9 type Speech Input Equipment.

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**Over 200—or more than 1/3 of the number of broadcasting stations in the United States—are Western Electric equipped.*

Western Electric

RADIO TELEPHONE BROADCASTING EQUIPMENT

Distributed by* GRAYBAR *Electric Company

Electronics, June, 1933. Vol. 6. No. 6. Published monthly. McGraw-Hill Publishing Company, Inc., 330 West 42d Street, New York, N. Y. $3.00 per year, 35 cents a copy. Foreign Postage, $4 U. S. Currency or 20 shillings. Canada (including Canadian duty), $3.50. Entered as second-class matter April 4, 1930, at the Post Office at New York, N. Y., under the Act of March 3, 1879.

O. H. CALDWELL
Editor
KEITH HENNEY
Associate Editor

electronics

McGRAW-HILL PUBLISHING COMPANY, INC.

Vol. 6, No. 6. New York, June, 1933

radio
sound pictures
telephony
broadcasting
telegraphy
counting
grading
carrier systems
beam transmission
photo cells
facsimile
electric recording
amplifiers
phonographs
measurements
receivers
therapeutics
traffic control
musical instruments
machine control
television
metering
analysis
aviation
metallurgy
beacons
compasses
automatic processing
crime detection
geophysics

A Job for the I.R.E.

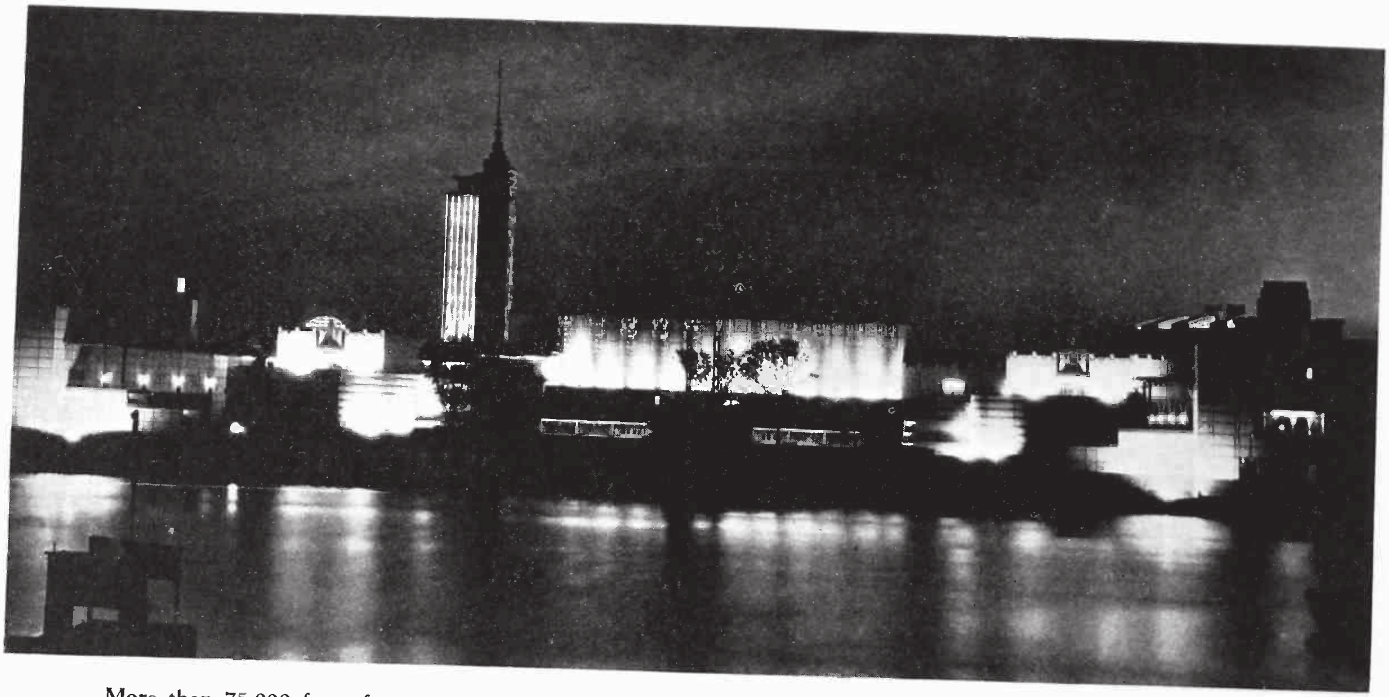
WITH events at Washington moving in the direction of industry control and government partnership in industry, it is likely that the radio manufacturers will shortly be called upon to set up a Code of Fair Competition under the expected new law. For this the instrumentality will undoubtedly be the Radio Manufacturers Association, which now has imposed upon it new responsibilities and opportunities such as never before. With the radio industry's Code of Fair Competition approved by the President, or by his delegated Radio Administrator (or "radio dictator"), the burden of price competition will then be lifted off the radio industry, and manufacturers and engineers can turn once more to their prime job of improving service and quality.

THIS will leave the radio engineers free to develop better technical equipment,—instead of engaging in price-whittling and quality-degradation which has been the sole theme in most engineering offices for twelve months past. It is to be hoped that the Institute of Radio Engineers will seize this opportunity to exert leadership in co-ordinating the work of radio engineers to produce a better complete radio system, all the way from microphone, through transmitting station, to the listener's set and speaker. This task of designing and engineering the whole chain, as well as its individual links, can become a timely theme at the Chicago Convention this month, providing a "new deal" in the technical as well as in the business end of radio.

A list of the I.R.E. papers will be found on page 173.

ELECTRONICS AT THE

"Century of Progress" Exposition opened by electronics, lighted by electronics



More than 75,000 feet of gaseous-tube lighting in various colors—red, gold, blue, green and purple—is employed in the illumination effects of Chicago's "A Century of Progress" Exposition

THE Chicago World's Fair of 1933 is an all-electronic exposition.

It was opened by electronics; it is lighted by electronics; in large measure it is being operated by electronics; and electronic phenomena and apparatus are among the outstanding features of its many exhibits.

And if the feet of the great American public are not so tired from tramping up and down 85 miles of exhibit aisles and corridors as to drive any other consideration than that of aching "dogs" out of its collective mind, that great American public is going to have a much enlarged and improved understanding of the electronic arts when it gets home from "A Century of Progress" exposition in Chicago this coming summer. The g.A.p. can save a lot of shoe leather if it will allow its electronic interest to be satisfied with explanations and demonstrations of basic phenomena, for these are shown in a most illuminating series of educational exhibits in the Hall of Science. But this is highly improbable, for undoubtedly the public will investigate thoroughly all parts of the Fair exhibits and everywhere will see or hear evidences and examples of electronic application.

Photocell control of lighting

The opening of the Fair, with its employment of a quantum of light energy from the star Arcturus caught by a photocell, was a triumphant gesture of electronics. That struck a keynote that continues its tone throughout the period and over the whole area of the Exposition. As on the opening night the big searchlight atop the west Skyride tower, nearly 700 feet in the air, picked out each major group of buildings with its beam and in response, by photo-electric cell control, each spectacular lighting display sprang into brilliance against the dark, so every night of the coming summer will the crowds gasp their "Oh's" and "Ah's" when the electronic lamplighter makes its appointed round. Man has never made a more impressive demonstration than this of the cosmic imperative, "Let there be light."

Fifteen miles of gaseous-tube lighting

And the distinctive new lighting units which characterize the 1933 Chicago Fair's general illumination are electronic—gaseous discharge tubes, 15 miles of them. Building facades will be outlined with them.

Among the most interesting of the new developments is the new cascade of green and blue light on the windowless walls of the Electrical Building, employing nearly a mile and a half of tubes. This waterfall effect is horseshoe-shaped, following the contour of the Electrical Building. Seven banks of green and blue gaseous tubes rise vertically 55 ft. at intervals along the wall. Spray and steam flowing from nozzles at the base of the wall heighten the cascade effect. In this display the tubes are all exposed, unlike the concealed-tube lighting which makes up the rest of the World's Fair architectural illumination.

Neon red, gold, blue, green and purple color combinations of tube units have been worked out, and altogether between 75,000 and 100,000 feet of gaseous discharge lighting is in use on the Exposition grounds.

An outstanding characteristic of the demonstrations

CHICAGO WORLD'S FAIR

Electronic apparatus and electronic phenomena featured among the many displays and exhibits

Loudspeakers throughout the grounds. Each of these 45 posts carries two speaker units, with the amplifier in the base

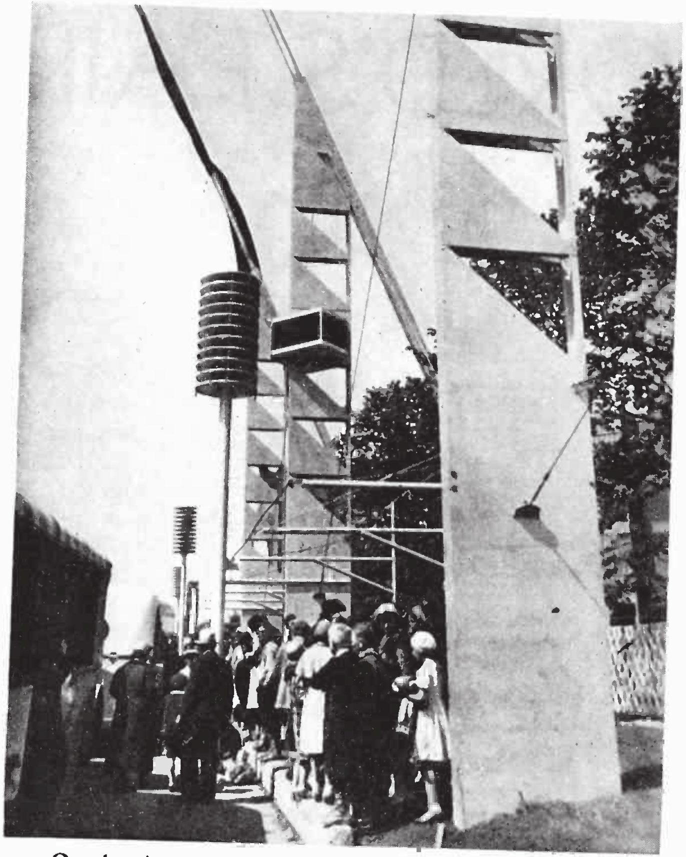
of electronic phenomena in the Hall of Science is their comprehensibility. Every electronic engineer who has wearied himself in trying to explain his art should tell his questioners to go to the Fair and see these exhibits. A previously uninformed person, after studying these demonstrations for a while and having a fairly good memory, can easily qualify as the neighborhood expert when he gets home. Here is the "Edison effect" explained in its own terms of operation, not by analogy or diagrammatic concept. A vacuum tube, not a little one, but big enough for its parts and operation to be clearly seen, has an emitting filament and two fluorescent plates. As their polarities are changed automatically the plates attract electrons from the filament and glow alternately while meters indicate the flow of current in the particular circuit thus energized.

Two pairs of neon lamps revolving concentrically in different diameters show by their stroboscopic effect in changing patterns the phenomena of full and half wave rectification. An oversize radio tube 12 inches high and 6 inches in diameter in association with indicating instruments shows how plate current is controlled by grid potential. Demonstrations of amplifying processes, of oscillation generation and control, of trigger type tubes—thyratron and grid-glow—of capacitive effects, of continuous wave modulation, of photo-electric effects, of piezo-electric phenomena, of the X-ray spectroscope, of beta and gamma rays and alpha ray tracks, of cosmic rays that people read about in the newspapers and of many other electronic phenomena are carried out in operation and movement that cause the visitor to stop and look, and, shortly, to understand. Probably in no laboratory or scientific display of any kind has there been presented so comprehensive and so lucid a demonstration of the fundamentals of electronics as is found in this series of exhibits in the Hall of Science.

Rectification is made comprehensible by this exhibit of revolving neon tubes whose changing patterns illustrate effect of rectifier tubes

But these do not by any means include all of electronic displays in the exposition. The Westinghouse, General Electric, Bell telephone, RCA and other groups have opened wide their research laboratories in their large exhibits. G. E. pursues its "House of Magic" theme with a 200 seat auditorium, so named, in which a continuous show of scientific vaudeville is presented. Westinghouse has set up its research demonstrations on a long mezzanine above its main exhibit with the experiments so arranged and equipped that visitors many operate or participate in them. Space does not permit an extended description of the many experiments and demonstrations in these exhibits, which include everything from radio power transmission to the latest developments in sodium vapor lamps. In the applications of electronics to power uses, the visitor can see into a mercury arc rectifier in operation and can watch the glow of a pair of phanotron tubes supplying direct current to a moving stairway.

All these things so far discussed are exhibits, demonstrations set up to explain and to educate. But these do not encompass completely the electronic aspect of the Fair. As previously stated, building illuminations are



On the Avenue of Flags, the speakers are mounted on the flag standards. At the left are the light sources

controlled by photoelectric cells and these versatile imps are found everywhere throughout the Exposition. Doors are opened by the waving of a hand, machinery is started by a shadow. Changing colors of fountains and gaseous tube illuminations, such, for instance, as the beautiful neon-mercury shaft in one of the General Exhibits building courts and the light cascades on the Electrical Building are electronically controlled.

But the populace expects, and it gets, in the Fair an outstanding example of radio and audio amplification.

Scattered about the Fair grounds are 120 loud speakers in 45 locations, some mounted on stands and building structures, but most of them set on poles about 30 feet high. The usual installation consists of two dynamic speakers mounted in a square quarter box with an amplifier in the circular seat at the base of the pole. There are four conductors carried underground in lead covered cable to each amplifier, two for the regular programs, one an order or talk wire and one the control conductor by which the amplifier is turned on and off. The control relays are operated by a pair of dry cells in each amplifier box. Power supply for each amplifier is taken from the nearest point at which 24-hour electric service is available. Normally the loudspeakers are controlled and operated in groups, but all may be handled as a unit or any single one may be operated independently. The system is so flexible that the music of a parade marching down an avenue may be amplified along the way and accompany each band as it comes closer, goes by and passes out of hearing. There are three main control stations, one in the Hall of Science, one in the replica of old Fort Dearborn and the third at the south end of the grounds in the Travel and Transport Building.

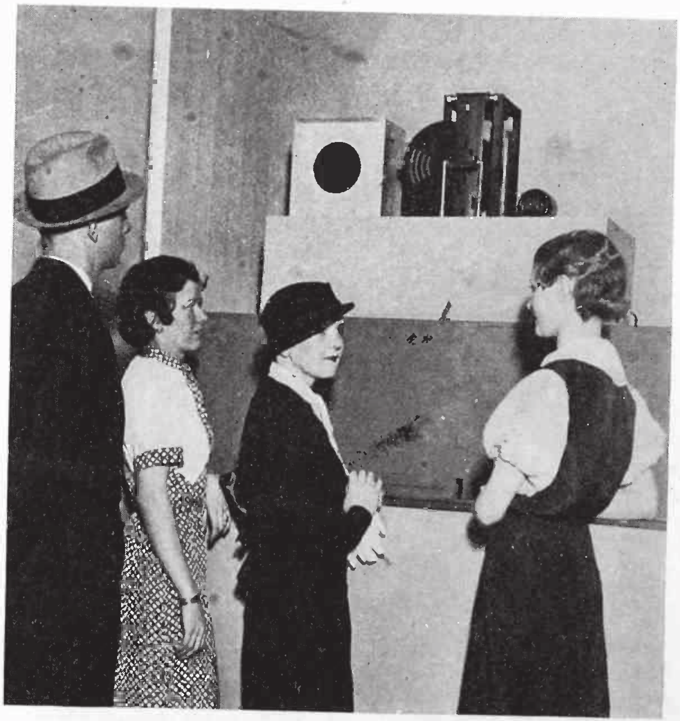
At 72 different points on the grounds are located pick-up stations for microphones, connected by 202 audio circuits to four main broadcasting studios. One of these, in the basement of the Administration Building, is a work studio only. The other three are in the "Hollywood" group of concessions and are used, in addition to broadcasting, for demonstrations of talking movie production, of television and for stage presentations. The audience capacities of these studios are 400, 800 and 2,500. All three stages are sound proofed from their respective auditoriums. Contracts have been made with local Chicago stations—WENR, WMAQ, WGN, KYW WLS, WCFL, WWAE and WIBO—and with the National Broadcasting Company and the Columbia Broadcasting System for programs originating in the Fair studios and pick-up points.

Many exhibit novelties

Radio and electronic principles are employed in many control functions in connection with exhibits outside of electrical apparatus. For example, in the display of the International Harvester Company a farm tractor, controlled by radio, is seen crossing a two-acre field, maneuvering, and returning, all under the direction of a radio transmitter and switchboard located at the edge of the field.

Another novelty is the RCA "color organ." In this instrument the production of color-tones corresponding to musical notes has for the first time been automatically synchronized by means of radio tubes. It is only necessary for the operator to start a record—the color organ automatically translates the recorded notes into color values.

Another curiosity is the "fire scanner" which shows the possibilities of the photoelectric cell as an automatic fire scanner. On the floor is a sheet iron pit into which balls of flaming waste paper may be thrown. Observing the pit constantly is a "scanner" consisting of a hose nozzle controlled by an electric eye. It moves right and left and up and down incessantly like a bear pacing its cage. The moment its eye perceives a flame it stops instantly and spurts forth a jet of water which extinguishes the flame. When the fire is out the water is shut off and the electric eye resumes its ceaseless patron.



This photo-electric siren is operated by series of holes to produce the proper frequencies, using a bar of light from a prism

Trends in radio design and manufacturing

ENCOURAGING signs are in the air—despite the long continued efforts of the radio industry to ruin itself on the rocks of squeak boxes made of tin. Not only is automobile radio on the up and up; not only are there signs of a revival of interest in high quality reception; but there is evidence that such reception will soon be possible in spite of the smallness of the sets now merchandised to virtual exclusion of consoles. And looming largely is the heretofore unheard-of vision of Government fostering, demanding, insisting on the radio industry cooperating within itself.

The public has taken to the small set like ducks to water. Encouraged by the manufacturers to discount ten years of advice on what constitutes high tone fidelity, the public has grabbed many products inferior in musical—even speech—reproduction, mechanically and electrically weak, potential liabilities for much service anguish.

But the public would not refuse a small set if good tone quality went with it. Progressive manufacturers are, therefore, ready to try on this long suffering, ever-game-public, the adventure of the external loudspeaker. The future may see radios sold in double units, the tuning mechanism housed in a small beautifully made cabinet, an external loudspeaker with sufficient baffle to provide good bass reception. Such a scheme would not only provide new purchasers with the desirable compact, near-at-hand tuning mechanism, but good quality to boot. Furthermore, it would persuade many owners of aged consoles to part with their antiquated receivers in favor of the better sensitivity and higher tone quality now possible plus automatic volume control, intercarrier noise suppression and all the frills of present day perfection.

The recent demonstration of binaural transmission and reproduction of music over a high quality (15,000 cycle) system capable of handling a wide range of volume (70 db.) without frequency or amplitude distortion proved conclusively the desirability of transmitting a wide band, and that binaural transmission was not an idle dream (*Electronics,* May 1933, page 118).

Hill-and-dale records

Those who long for high-class home entertainment will find further encouragement in the possibility that the long-playing vertically-cut records of Dr. Fredericks (Bell Laboratories) may be available to the public. These records transmit a wide range of volume and are good up to 10,000 or more cycles. Played on the proper instrument with sufficient power and the proper speaker system they will provide entertainment of the highest caliber.

These two possibilities, the transmission of three-channel high band-width sound to various cities over the Bell System and the sale of high-class reproducing machines with hill-and-dale records constitutes a threat to the radio industry to think of something besides cheapness of sets.

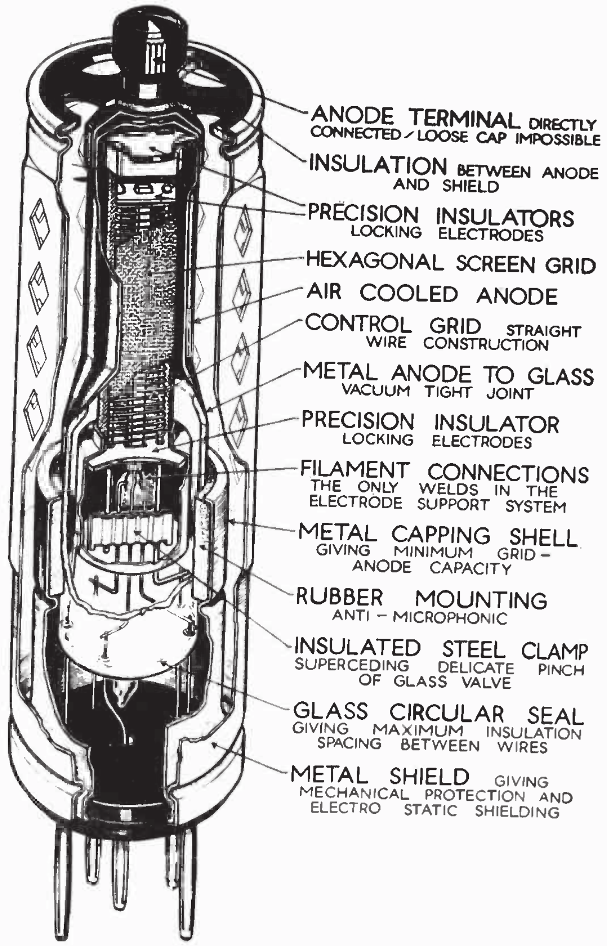
Circuit engineers in their search for methods of reducing the space required for a given sensitivity and selectivity and for reducing costs are leaving no stones, old or new, unturned. Lessons in economy learned in the hectic a.c.-d.c. scramble are being utilized in strictly a-c sets.

The long dead reflex is being revamped (page 153, this issue). A single tube now acts as second detector, intermediate frequency amplifier, audio-frequency amplifier, a.v.c. tube and possibly inter-carrier noise suppressor. Together with the electron-coupled oscillator, the reflexed tube will permit a seven tube set to be compressed into four tubes. Even the power tube may be worked twice in some sets, once at i.f. The authors of the reflex data in this issue point out that years ago, reflex circuits received considerable attention and extensive application, because of the relatively high price of tubes, the high order of sensitivity required to receive weak or distant broadcasting stations, and the heavy drain on batteries by the tubes then available. Any circuit combination which gave greater sensitivity for a given number of tubes was considered meritorious. Consequently, reflex circuit-arrangements were used extensively since they answered many of the design problems encountered at that time.

Mechanical strength forms one of the advantages of the all-metal tubes

Later the reflex circuit was dropped, disappearing from use entirely. The reasons for its loss of popularity were primarily the poor stability obtainable with the available triodes, the poor quality of output, and the introduction of cheaper and more efficient tube types which permitted the use of more tubes in the set without greatly increased cost or excessive battery drain. Furthermore, the growing demand for a single-control receiver which would give approximately maximum sensitivity at any dial setting, did much to push the erratic and complicated reflex receiver into temporary discard.

The spontaneous public approval accorded the introduction of the "pocket size" compact receivers has led


ANODE TERMINAL DIRECTLY CONNECTED / LOOSE CAP IMPOSSIBLE
INSULATION BETWEEN ANODE AND SHIELD
PRECISION INSULATORS LOCKING ELECTRODES
HEXAGONAL SCREEN GRID
AIR COOLED ANODE
CONTROL GRID STRAIGHT WIRE CONSTRUCTION
METAL ANODE TO GLASS VACUUM TIGHT JOINT
PRECISION INSULATOR LOCKING ELECTRODES
FILAMENT CONNECTIONS THE ONLY WELDS IN THE ELECTRODE SUPPORT SYSTEM
METAL CAPPING SHELL GIVING MINIMUM GRID-ANODE CAPACITY
RUBBER MOUNTING ANTI-MICROPHONIC
INSULATED STEEL CLAMP SUPERCEDING DELICATE PINCH OF GLASS VALVE
GLASS CIRCULAR SEAL GIVING MAXIMUM INSULATION SPACING BETWEEN WIRES
METAL SHIELD GIVING MECHANICAL PROTECTION AND ELECTRO STATIC SHIELDING

Construction of all-metal tubes

radio engineers to an almost frantic search for new circuits and new methods which would give improved performance without an increase in the size or cost of the set. The number of parts and tubes which can be put in the chassis space available in these small receivers is now, and has been, at the saturation point. The use of duplex tubes has been a considerable aid to performance capabilities without an increase in chassis size.. In automobile sets the problem is to get the best performance possible with the smallest drain on the car's battery. Consequently, the next logical step is to make some of the tubes perform additional functions. Reflexing may be the answer to these problems.

With reflex arrangements, higher gains are attainable with a given number of tubes than with a straight circuit. The size and weight of the chassis are not much increased by the use of reflex circuits, while current consumption remains the same.

While fewer tubes are used with a reflex circuit to secure the same overall gain, the cost of circuit elements is slightly higher for a reflex arrangement, since filters must be provided to isolate the reflexed frequencies. The increased cost and complication of the circuit may offset the saving in tube costs for a straight circuit. Consequently, the principal advantages of the reflex-circuit may be its economy of space, and reduced power consumption.

The electron-coupled oscillator is a distinct advance. It improves the set. It is difficult to put in the same category all of the many hybrid tubes brought out at apparently the slightest pretext. Since the new numbering system went into effect a new tube has appeared at least once a week, often differing but slightly from tubes already in production.

Where the tube manufacturer is to get a profit remains a mystery. He has got himself out of the quantity production basis onto a piece work scheme. No sooner does a tube become popular enough to be built at a high speed, and at low cost, than he combines it with some other tube into a small production item complicated to build, expensive to test and to throw away if not up to specification.

In spite of the economical uncertainty, at least two of the larger tube plants are expanding their manufacturing facilities, secretly hoping that most of their competitors will go out of business and thereby permit themselves a profit. Tube manufacturers report more rapid swing toward the use of SVEA metal for plates and support wires.

All metal tubes

First announcement of the Osram Catkin all-metal receiving tubes in England must be taken seriously in this country. This is a combined Osram-Marconi development and at the moment seems to be of considerable importance. It will change the appearance of tubes, will increase their stability and rigidity, lower the shipping cost, etc.

Fundamentally, the tubes resemble large water-cooled tubes. These have exposed anodes, glass being used only for the seal. The catkin tube takes its name from the fact that the transmitters with exposed anodes were called "cooled anode tubes" (cats) and the new tubes being smaller, were give the diminutive title.

According to Osram (General Electric Company, Ltd.) the features of the metal-envelope tubes are as follows:

1. Uniformity of characteristic, due to new methods of support and mounting the electrodes.
2. Absence of electrostatic charges due to the elimination of the insulating envelope. Screen-grid tubes have lower grid to anode capacity. The tube is self-shielded.
3. Greater cooling. In the case of power output tubes a higher rating can be put on the tube. Output tubes are supplied without the outside screen, the anodes being coated with a heat-resisting and insulating enamel.
4. Elimination of losses in the seal. Mica is used instead of glass in the pinch and steel supports insure rigidity.
5. Non-microphonic mounting.
6. Retention of high vacuum. The air cooled anode and the elimination of glass reduces the evolution of gas during use.

COMPONENTS MARKET IN 1932

Component	1932 Average Price	Number Per Set	Total in millions	1932 Market Value
Sockets	$.022	8	20.8	$400,000
Audio transformers	.70	1	2.6	1,820,000
Power transformers	1.47	1	2.6	3,820,000
Power chokes	.60	1	2.6	1,560,000
Loudspeakers	1.65	1.1	2.76	4,550,000
R-F coils	.17	4	10.4	1,770,000
Tuning condensers	.65	1	2.6	1,690,000
By-pass condensers	.09	9	23.2	2,080,000
Filter condensers	.33	2.5	6.5	2.140,000
Fixed resistors	.04	10	26.0	1,040,000
Volume controls	.26	2	5.2	1,350,000
Total				$22,220,000

[Continued on page 161]

Reflex circuit considerations

By J. M. STINCHFIELD
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*RCA Radiotron Company—
E. T. Cunningham, Inc.*

IN THE search for ways to increase the effectiveness of a radio receiver without increasing its cost or its space requirements, engineers have naturally thought of reflexing one or more of present-day multi-element tubes. The discussion below deals not only with the fundamental principles of reflex but of the difficulties in using it, its advantages and some general comments on the design of reflexed circuits.

In Fig. 1 is shown a fundamental reflex circuit, employing a pentode and a diode, the former reflexed so that it amplifies both i-f and a-f voltages. The two tubes shown can be replaced by a single tube of the 6B7 type. In operation, the incoming i-f signal is passed through T_1 and amplified as usual. The plate circuit of the i-f amplifier also includes the a-f load (R_4) by-passed by C_4 to make the impedance for i-f relatively low. The diode detector is coupled to the i-f amplifier through T_2. Detection of the signal takes place in the diode, producing an a-f output which is fed through an i-f filter (R_2C_3) back to the control grid. It prevents any i-f component from being fed back to the control grid of the pentode. In passing to the control grid of the pentode, the a-f signal will pass unaffected through the secondary of T_1, of relatively low impedance to a-f. The a-f signal is then amplified by the pentode, producing an a-f voltage across R_4. Although the primary of T_2 is in the plate circuit, it has little effect on the a-f plate current due to its relatively low impedance to a-f. Thus it is possible to develop an a-f voltage across the a-f load (R_4) which can be fed to another stage of a-f amplification or an output tube.

From this elementary discussion of a typical reflex circuit, it will be seen that the operation of the circuit depends upon its ability to separate the reflexed frequency from the other frequency. Naturally, it will be simpler to design circuits for frequencies which differ widely. For this reason, the reflexing of a-f voltages through an i-f amplifier is perhaps the simplest. However, it is possible, although considerably more difficult, to reflex i-f through an r-f amplifier.

In Fig. 2 is shown a typical family of plate characteristic curves for a pentode amplifier. A load line *A-O-B*, representing an effective a-f load of 83,400 ohms is shown. The static center of the a-f swing is the point *O*, showing that a bias of —2.75 volts is required. The amplitudes of the a-f swing may be *OA* and *OB*.

Since the amplitude of the a-f swing are much larger than the amplitudes of the i-f swing, due to the amplification of the system, the dynamic center of the i-f swing will be moved up and down along the a-f load line. The location of the dynamic center of the swing at any instant will depend upon the instantaneous value of the a-f voltage applied to the grid of the tube.

An i-f load impedance of 313,000 ohms is represented by the load lines, *L-A-M* and *P-B-Q*, at the extreme ends of the a-f swing. The i-f load with no a-f signal on the grid of the tube is represented by the line *X-O-Y*.

If the characteristics of the tube could be made absolutely linear over the entire range of the a-f and i-f swings, the tube would be ideal for reflex amplification. Since the characteristics are not absolutely linear, some distortion is introduced, and the selection of the proper load becomes important for stable operation.

It is apparent from the curves that the a-f voltage is distorted but slightly by the curvature of the characteristics. The dynamic center of the i-f voltage swing, however, is carried back and forth along the a-f load by the a-f grid voltage. Consequently, the i-f plate voltage amplitude is subjected to considerable change with respect to the i-f grid voltage amplitude. Hence the i-f voltage is distorted. An appreciable part of this distortion is eliminated by the tuned i-f circuit, but the percentage of modulation of the i-f signal is also changed.

When an unmodulated i-f signal voltage is applied to the input of the circuit shown in Fig. 1, a d-c voltage is developed across the load resistance (R_1) of the diode. The point *F* (Fig. 1) becomes negative with respect to the cathode. An increase, or decrease, in the i-f amplitude due to modulation increases, or decreases, the negative potential at the point *F*. The changes in potential occur at a-f. The a-f voltage is directly effective at the grid of the reflexed tube through the coupling connection R_2 and C_2. The changes in potential at the grid and at *F* are identical in sign with respect to the cathode.

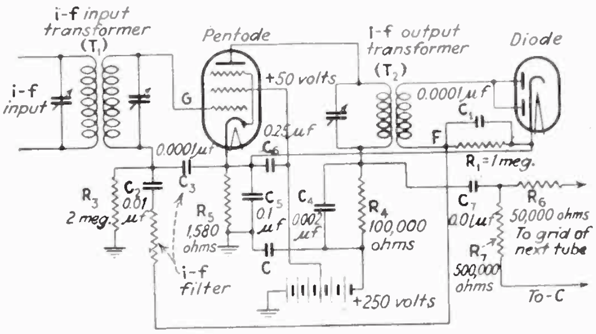


Fig. 1—Typical reflex circuit. In this case the diode and pentode are distinct; they may be combined in a single envelope, such as the 6B7

It is evident that when the modulation increases the amplitude of the i-f signal, the dynamic center of the i-f swing is shifted by the a-f voltage towards the point *B*. Similarly, when the carrier is modulated downward (decreased i-f amplitude), the a-f voltage shifts the dynamic center of the i-f swing towards *A*.

The spacing of the grid voltage lines (Fig. 2) increases towards *A* and decreases towards *B*. This causes a decrease in the percentage of modulation of the i-f signal, since the small amplitudes are amplified more than at point O and the large amplitudes are amplified less. This decrease in the percentage modulation has a stabilizing effect of the system, while the gain and output are reduced slightly.

If the output of the diode detector were connected to the grid of the reflexed tube in the opposite phase, there would be an increase in the percentage of modulation. This effect tends to be accumulative and motorboating may result.

Consider the normal stable circuit arrangement with the loads shown in Fig. 1. Suppose a small, modulated i-f signal is applied to the input and its amplitude is gradually increased by means of a gain control operating on the preceding amplifier stages. When the positive a-f voltage swings the grid appreciably beyond the point A, the i-f amplitude no longer receives increased amplification as compared with that at the point O, due to the curvature of the characteristics near the point C. The amplification rapidly decreases beyond the point A, causing a further decrease in i-f amplitude to the detector, which in turn causes a more positive grid voltage on the reflex tube.

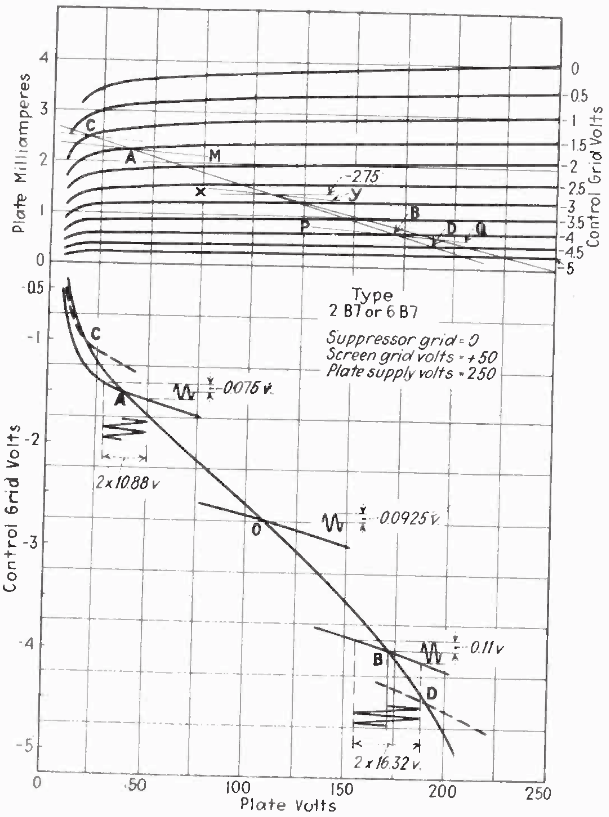


Fig. 2—Plate characteristics of the 6B7 or 2B7 and (below) the dynamic a-f characteristic

Stable operation is obtained, if the change in the i-f amplification over the operating range of the a-f grid voltage values produces a distortion of the modulated i-f which, when rectified by the diode, causes a considerably larger change in the a-f amplitude at the lower end of the grid swing than at the upper end (Fig. 2). Even though the characteristic at the upper end tends to produce an increase in percentage of modulation, the characteristic at the lower end is counteracting this effect.

In general, for stable operation in reflex circuits, the i-f voltage amplification over the operating range must either be constant, or tend to oppose the changing amplitude of the input carrier-voltage.

The limiting conditions for stable operation, therefore, depend upon the a-f and i-f loads, the plate, screen, and grid-bias voltages. It is necessary to use a somewhat lower screen voltage than that normally used in i-f amplifiers in order to obtain high a-f voltage-amplification. The control-grid bias must be selected so that the tube operates near the central part of the plate characteristics to obtain maximum output and stable operation. High output requires high plate voltages, particularly when resistance coupling is employed.

The i-f plate load impedance and the a-f load impedance should not be too high. Low impedances give better stability, but also, low voltage-amplification. While it is possible to secure volume control on the reflexed tube, it is generally more satisfactory to use a volume control operating on preceding tubes.

Analysis of operation of circuit

The 100,000 ohm load resistance (R_4 in Fig. 1) and a bias voltage of -2.75 volts place the static center for the a-f plate voltage swing at a favorable point (O in Fig. 2) on the plate characteristics for a plate supply of 250 volts and screen voltage of 50 volts. The grid resistor (R_7) in parallel with load resistor (R_4) constitute the a-f load (R_p a-f) of 83,400 ohms. This load is represented by the line A-O-B in Fig. 2.

The transformer (T_2) has a primary to secondary voltage ratio (N_E) of 1.7 to 1. The parallel resonance impedance of the primary (Z_{pr}) is 400,000 ohms. The secondary of T_2 is loaded by the diode. The diode impedance (Z_D) to the 175 kc. i-f is approximately one-half of R_1, or 500,000 ohms. The resistance and reactance of the secondary T_2 are negligible in comparison with this diode load. Therefore, the total i-f plate load impedance is the parallel value of Z_{pr} and the reflected diode impedance, or 313,000 ohms.

The points A and B mark the limits of the assumed a-f plate voltage swing on the dynamic a-f characteristic in Fig. 2 (obtained by projecting instantaneous values of grid voltage and plate voltage from the load line A-O-B). The amplitude of the fundamental a-f plate voltage swing is 67 volts. This corresponds to a grid voltage swing of 1.25 volts, giving a voltage amplification of $67/1.25 = 53.5$.

Since the voltage produced across the diode load (R_1), modified by the voltage ratio of the network comprised of R_2, R_3, C_2 and C_3 gives the a-f grid voltage swing, the voltage across R_1 must be equal to

$$1.25 \times \frac{R_2 + R_3}{R_3} = 1.44 \text{ volts (over the frequency range for which } C_2 \text{ and } C_3 \text{ are negligible).}$$

For a diode efficiency of 90 per cent, the amplitude of the i-f modulation on the secondary of T_2 is $1.44/0{,}9 = 1.6$ volts.

With 20 per cent modulation, the i-f signal voltage on the secondary of T_2 is $1.6/0.20 = 8$ volts. The voltage on the primary of T_2 is the voltage in the secondary times the step-down ratio of the transformer $= 8 \times 1.7 = 13.6$ volts. Since this voltage is 20 per cent modulated, it varies between 16.32 volts and 10.88 volts.

Since the d-c voltage across the diode load (R_1) increases with increasing i-f voltage, the maximum value of a modulated wave causes the highest voltage, while the minimum causes the lowest voltage. The d-c voltage change across R_1 produces the instantaneous a-f grid voltage on the tube. Consequently, when the modulated i-f voltage swing is 16.32 volts the dynamic center is at B, when it is 10.88 volts the dynamic center is at A.

It will be seen by inspection of Fig. 2 that the i-f voltage amplification for a given i-f amplitude depends upon the instantaneous grid voltage. The voltage amplification is low at highly negative values of grid voltage, and it increases gradually as the negative grid voltage decreases towards point A. For negative grid voltages less than that at A, the amplification begins to decrease rapidly, until at C it is considerably lower than at A. The decrease in voltage amplification at C is due to curvature of the plate characteristics for low plate voltages.

The amplification at points A and B is found from the i-f load lines on the dynamic characteristics, and it equals the ratio of the peak-to-peak plate voltage swing to the peak-to-peak grid voltage swing. At A the amplification is $2 \times 10.88/2 \times 0.075 = 145$. At B it is $2 \times 16.32/2 \times 0.11 = 148.2$.

As brought out in the discussion on the theory of operation of a reflex amplifier, stable operation can exist only when the i-f amplification is constant or tends to oppose the changing amplitude of the input carrier-voltage. Under the conditions obtaining at A and B, the modulation of the i-f signal is increased, due to the difference in amplification at these points. Due to the distortion of the a-f amplitude, the a-f grid voltage is not sinusoidal as assumed for the construction of Fig. 2. The point B actually should be more distant from O than point A, and not as shown.

With a slightly larger amplitude of i-f input the stabilizing effect of the unequal a-f amplitudes no longer predominates and the system becomes unstable. Larger i-f amplitudes cause the points A and B to move away from O into regions of increasing instability until the tube draws grid current. As a result of grid current, the point O is shifted to a more negative value, restabilizing the system for an instant. The rapid reoccurrence of this phenomenon is the so-called "motorboating" effect. For smaller a-f plate voltage swings, the voltage amplification in the direction of A becomes greater than that in the direction of B, producing slight demodulation. This condition adjusts itself instantly, so that stable operation is obtained.

Higher percentages of modulation require smaller i-f grid voltages for the same audio output. Therefore, larger audio-output voltages can be obtained without exceeding the i-f grid voltage swings which mark the end of stable operation. The following table shows the results of experiments which illustrate this:

Per cent modulation of i-f signal	Peak a-f output voltages for stable operation
10	45.3
20	64.0
30	79.0
50	105.0
80	116.0

The values for 50 and 80 per cent modulation show that the entire a-f dynamic characteristic is used, and they represent the maximum possible voltage-output obtainable without causing the tube to draw grid current.

The calculation shows that the i-f amplification is 145 and the a-f amplification is 53.5. Due to the step-down ratio of T_2, the overall i-f gain is $145/1.7 = 85.4$. The gain of the entire circuit of Fig. 1 with an i-f signal of 20 per cent modulation is $67/0.0925 = 725$, for 30 per cent the gain is 1,090 and for 100 per cent it is 3,625.

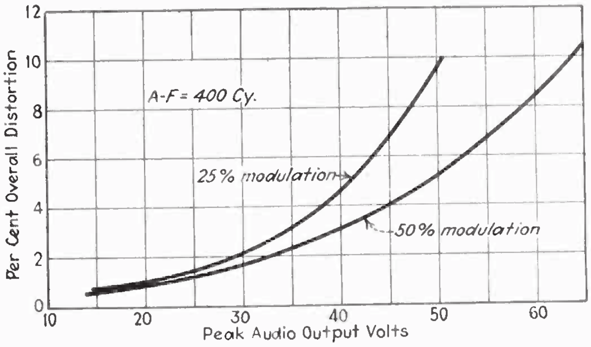


Fig. 3—Distortion from the reflex circuit and tube showing decrease at higher modulation due to weaker necessary i-f signal

Harmonic analysis shows a distortion of 2.7 per cent for the a-f amplifier alone with a peak plate voltage swing of 64 volts. The measured overall distortion is shown versus the peak a-f output in Fig. 3. The measured overall distortion is considerably higher than the calculated value for the a-f amplifier alone since it contains distortion due to the change in percentage modulation of the i-f signal, and also the distortion of the diode detector.

Reflex circuit design

There should be no a-f coupling between the plate circuit of the pentode (Fig. 1) and the diode-detector circuit, if audio-feed-back and audio-rectification are to be avoided. The capacity between the T_2 primary and secondary windings should be low to eliminate a-f coupling. There should be no i-f coupling between the plate circuit of the pentode, or the diode circuit, and the grid circuit of the pentode, since i-f feed-back will cause oscillation or degeneration.

In resistance-coupled circuits, the plate supply voltage should be at least 5 times as high as the screen grid voltage. The audio load should be placed for low distortion and be such that the least negative required peak grid-voltage value does not occur at too low a plate voltage. The reflexed a-f voltage must return to the control grid of the reflex tube in the proper phase. In resistance coupled circuits such as that shown in Fig. 1, the correct phase relation automatically obtains. In transformer coupled circuits, the polarity of the a-f transformer must be correct.

For an i-f signal of given percentage modulation there may be a limiting amplitude beyond which instability results. The i-f and a-f plateload impedances have critical values which determine the limits for stable operation. If the volume is controlled only by varying the a-f voltage fed back to the reflex tube, rectification of the i-f in the plate circuit of the reflex tube will, at low volume levels and high i-f input voltage, introduce some a-f voltages which may be appreciably distorted. For this reason it is generally advisable to control the volume on some other tube in the set.

Self-bias is recommended, since the operation with correct loads will remain satisfactory for a considerable variation in plate-supply voltage.

With present tube types it is possible to design reflex receivers having performance capabilities comparable with those of a straight receiver employing a larger number of tubes. The stability and output quality of the reflex receiver can be made to compare favorably with that of receivers employing straight circuits.

RADIO BROADCAST

Washington situation and International Radio Conference, July 10, add to complications

ONCE again the radio broadcasting situation is in a state of flux. New ideas in the use of the wave channels are being brought to the light of day. A new allocation along new lines of international requirements is not outside of the early possibilities. And even the Federal Radio Commission itself may be abolished or tucked into the Department of Commerce, with a Director of Radio reporting to the Secretary of Commerce, and a commission sitting merely as an appellate body. No less radical is the "new deal" now facing radio, than have been the many other new policies to which Washington is now getting accustomed.

Meanwhile the Supreme Court of the United States has handed down a decision in the WIBO case which has the effect of imposing absolute authority in the Federal radio administrative body (at the present time the Commission), giving it powers to grant, transfer or cancel transmitter licenses at will, thus at last putting the final stamp of complete power on the Commission. Such a ruling sustaining the Radio Commission would have been generally regarded as a stabilizing influence by the station licensees, were it not for the fact that the broadcasters and others are getting to feel little confidence in the actions of the Commission, as based on other than political pressure and expedience, rather than radio principles. At the present time therefore consternation reigns among the broadcasters and other licensees of desirable channels, not knowing when the new political autocratic power may run amuck and lop off heads and transfer licenses, regardless of the service records and radio performance of the parties involved.

To a degree never before observed, political influence seems now to be the force which sways the Commission's actions, as it carries out the behests of political commanders with all the unassailable authority of its new-found autocratic power, based on the Supreme Court's decision.

North American conference still doubtful

For months the United States authorities have waited for an invitation from the Mexican Government to take part in the long-planned North American Radio Conference, at which the wavelength situation on this continent could be worked out between the United States, Canada, Mexico and Cuba. The date now set is July tenth. Mexico is known to be busy building new broadcast transmitters just over the border, with one station rated at 500 kw., the most powerful unit on the continent. Perhaps the plan in the Latin-American mind is to have more of these high-power pounders of the ether ready for operation, before going into a conference at which the plums of the air are to be re-distributed.

Increasingly it also becomes evident that from such an international conference the United States has only to lose, and nothing to gain. If agreement among the American interests could be reached as to some basis for widening the broadcasting band, it might then at least be possible to have "more loaves and fishes" to pass around. But so far the American committees themselves cannot get into concord as to the united American policy to be maintained. The shipping interests have blocked the broadcasters' appeals for a widened broadcast band, the Navy has sided with the shipping point of view, and the Army has backed the Navy, so that a deadlock in the American position now obtains. If the American delegates cannot find out what their own nationals want, the difficulties of the international conference table are further enhanced.

With the existing broadcast channels to be divided among the other three countries expected, the United States is bound to come out with less wavelengths than before. At once this will precipitate a reallocation of United States stations, and then the floodgates will be opened for appeasement of political demands that have been collecting over many months. In such a reallocation, substantial stations and chain outlets are likely to be the chief sufferers, and the listening public will undergo further reduction of its prime broadcasting facilities.

Demands for power increases

Meanwhile there is a vigorous movement among the medium-size and regional stations to effect a horizontal increase of power on shared channels. Nearly all engineers are agreed that if the several stations sharing a channel all increase their powers proportionately, such as double or even tenfold, the relative interference between the stations will be unchanged, and the net result will be higher field strength laid down in all service areas, offsetting static and electrical interference so much more effectively. Thus it is pointed out that all the regional and local stations might share in a general increase of power, and while the heterodynes in unserved areas might become more vociferous, the effect in all listening areas would be to give more satisfactory service to the public. The Commission has been very slow to admit this principle, with its well-known skittishness at any increase of that mysterious thing called "power," which the politicians can kick up a rumpus about. It is probable therefore that nothing will be done about this horizontal power increase at present—at least not until all stations on all channels involved have voluntarily agreed to increase, and also not until after the problematical North American Conference, which may leave as its aftermath more channels to be doubled up.

New chains, new methods of linking up local stations for chain operation, and new short-wave plans are also buzzing around Washington at this time. Each of the new chain proposers claims unlimited political influence with the practical men in the new Administration, and the claim of each is that his own group of favored 100-watt stations will during the first month of operation have their powers increased to the clear-channel dimensions of corresponding NBC and CBS station ratings!

In this direction of short-wave interconnection of regional and local stations one of the most interesting and constructive suggestions is that which has originated

PROBLEMS GATHER

Politics rampant. New chains proposed. Possibilities of short-wave distribution of programs

with Federal Radio Commissioner Harold A. Lafount.

"Many of the 450 stations now affiliated with the chains, and 50 others who broadcast chain programs only a small portion of their time, are having trouble in providing worthwhile sustaining programs," declares Mr. Lafount, adding: "A recent study shows that there are approximately 25,000 hours per week of unsold time now being used for sustaining programs.

"We now have 605 licensed broacasting stations in this country. A study of the published programs of each of the major chains reveals the fact that of that number, from 26 to 132, or an average of 79 stations, broadcast network programs. Dividing a day of a typical week into three parts, the published programs indicate that an average of 58 stations are on the three networks between 6:45 a.m. and noon; 88 stations between noon and 6 p.m.; and 86 stations between 6 p.m. and midnight. The number of hours per week when there are 100 or more stations on the three networks combined are as follows: 2½ hours before noon; 11 hours between noon and 6 p.m.; 6 hours between 6 and 10 p.m.; and 9 hours between 10 and 12 p.m.

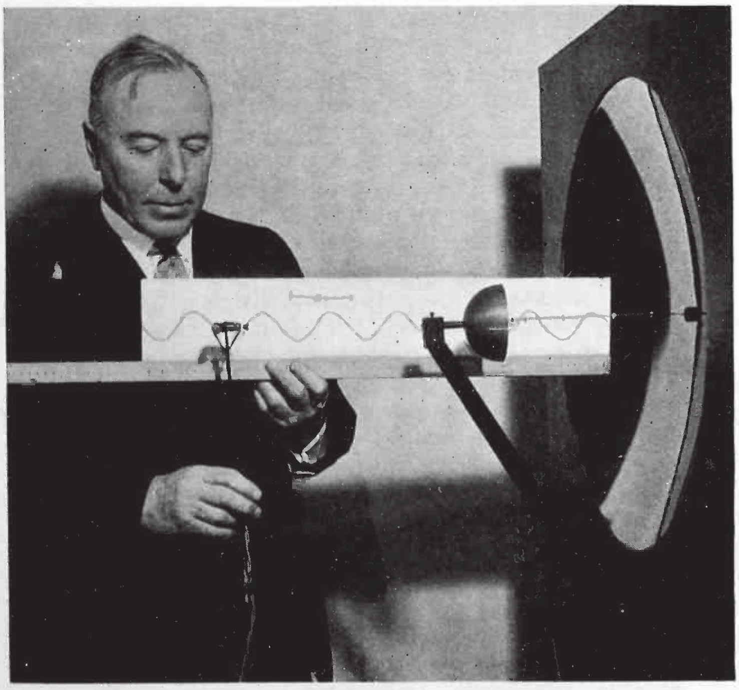
"The object of presenting these figures on chain broadcasting is to show that on an average we have over 500 stations broadcasting local programs, whose unsold or sustaining programs I seek to improve, and by so doing to offer a plan to put to immediate beneficial use already existing facilities, thus eliminating waste, and providing educational programs to *all* our people.

"Educational programs could, and I believe in the near future will, be broadcast by the Government itself over a few powerful short-wave stations, and then rebroadcast by existing local broadcast stations. This would not interfere with local educational programs, and would provide all broadcasters with the finest possible sustaining programs. The whole nation would be taught by one teacher instead of hundreds, and would be thinking together on one subject of national importance. I shall not undertake a description of the mechanics of this proposed plan, other than to say it would be very flexible and inexpensive. I do not consider this a step towards Government ownership or operation of radio broadcasting stations. The Government's activities would be confined to the transmission and wholesale distribution of educational material and discussions of subjects of national importance to all the stations in the United States, and not to the maintenance of any particular station."

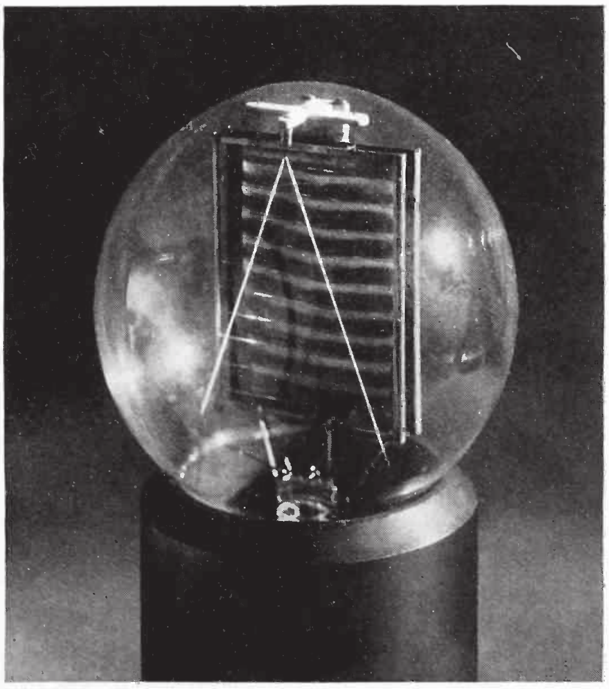
In discussing the proposal, it was suggested that Army and Navy short-wave stations are now available which could be used to put the plan into immediate operation.

* * *

TWO OUT OF HUNDREDS OF ELECTRONIC NOVELTIES AT CHICAGO WORLD'S FAIR



An ultra-shortwave generator producing 9-centimeter waves, is shown having its output measured by Dr. S. M. Kintner, vice-president and chief engineer Westinghouse company. The output of one watt of power can be reflected like light, but penetrates smoke and fog unimpeded.



In this huge model of a three-element tube, exhibited by the Bell Telephone Laboratories, the plate is coated with a fluorescent material which glows proportionally to the number of electrons which come from the filament.

Radio system for

landing aircraft during fog

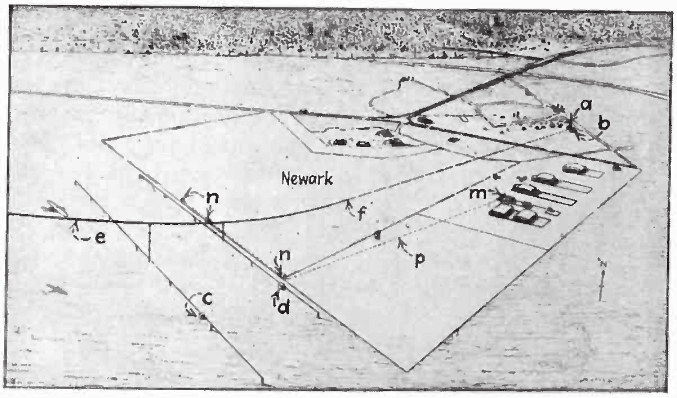
Installation at Newark Airport

By H. DIAMOND

Bureau of Standards

FROM its infancy, aviation has relied upon the radio art to serve as its eyes and ears. The radio range-beacon, for guiding aircraft over invisible radio airways, and the radiotelephone, for carrying on two-way communication between aircraft and ground, are examples of such dependency. However, these aids have hitherto proved insufficient to free scheduled air transportation from interruptions due to low visibility. An aircraft arriving over an airport in dense fog has previously lacked means to permit it to come safely to ground. Radio has again come to the aid of aviation in providing these means.

Tests and demonstrations carried on at the Newark Municipal Airport, Newark, N. J., during March and April, 1933, indicate the complete practicability of the Bureau of Standards system developed to assist aircraft in making safe landings under conditions of zero visibility. The work on this system was conducted by the Research Division, Aeronautics Branch, Department of Commerce, at the Bureau of Standards. The system employs three elements, a runway localizing beacon, marker beacons, and a landing beam, to provide continuous and accurate information on the position of the aircraft in three dimensions as it approaches and reaches the instant of landing.



(a) Runway localizing beacon, (b) landing beam, (c) approach marker beacon, (d) boundary marker beacon, (e) spatial landing path followed by landing aircraft, (f) point of contact with the ground, (m) location of monitoring equipment and ground two-way communication set-up, (n) remote control stations for two-way equipment.

Fig. 1—Installation of radio landing system at Newark Municipal Airport

The runway localizing beacon gives indications of the directional position of the aircraft with respect to the airport and permits keeping the aircraft directed to and over the desired landing runway. A 200-watt set of the visual beacon type, operating on 278 kc. feeds two small, multi-turn loop transmitting antennas, modulated with 65 and $86\frac{2}{3}$ cycle notes, respectively. The intersections of two figure-of-eight space patterns produce four equi-signal zones of courses. Along each course, the signals received from the two loop antennas are equal, while on each side of the course the signal received from the nearer antenna is the stronger. Means on the airplane for comparing the relative magnitudes of the received signals guide the pilot.

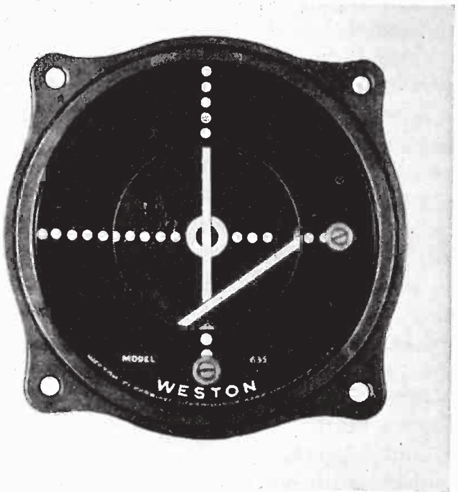


Fig. 2—Combined instrument used for securing lateral and vertical position of the landing aircraft

The orientation of the beacon courses is governed by the wind conditions at a given airport. To take care of all wind conditions the runway beacon may be located underground at the center of the field and one of the four courses may be rotated to coincide with the prevailing wind direction. A study, however, of meteorological data for a number of airports has shown that the wind during low visibility generally comes from one major direction. At the Newark Airport this is usually from the northeasterly quadrant. The runway beacon, accordingly, is located at the northeast end of the field and one of the courses is oriented along the northeast-southwest runway. With the aid of a goniometer to swing the course anywhere between the two hangar lines, service can be given for winds from this quadrant.

On the aircraft, the same receiving set used for radio range-beacon signals and weather broadcasts is employed for the runway beacon signals. This set is augmented by a reed converter to convert the beacon signals to pointer-type course indications, and also by an automatic volume control (a.v.c.) unit to relieve the pilot of adjusting the sensitivity of the receiver as the distance between the airplane and the ground station changes. The reed converter employs two vibrating reeds tuned to the modulation of the runway beacon (65 and $86\frac{2}{3}$ cycles) and driven by electromagnets actuated by the output signals from the receiving sets, so that the amplitudes of vibration of the two reeds indicate the relative amounts of the two signals. The motion of each reed induces a voltage in a pick-up coil, the magnitude of which is proportional to the amplitude of reed vibration. The two generated voltages are rectified and applied differentially to the movement operating the vertical pointer of a combined instrument (see Fig. 2).

A vertical index line across the face of this instrument represents the landing field runway, while the vertical pointer shows the relative position of the aircraft with respect to the runway. When the two rectified voltages are equal, the vertical pointer is at zero-center and coincides with the vertical index line, indicating that the airplane is on the runway course. A reversing switch makes the deflection of the pointer and the direction of deviation of the aircraft coincide whether the aircraft is flying *away from* or *toward* the beacon.

Distance indicator and marker beacons

Longitudinal position of the aircraft as it approaches the airport is given by the combination of a distance indicator on the aircraft with the aural signals received from two marker beacons.

The distance indicator consists simply of a d.c. milliammeter connected in the plate supply to the r.f. tubes of the beacon receiver. Since the a.v.c. increases the negative bias on the grids of these tubes with increasing input voltages the plate current is approximately inversely proportional to the field intensity of the runway beacon. The instrument may therefore be calibrated approximately in miles from the beacon (say, 0 to 5 miles).

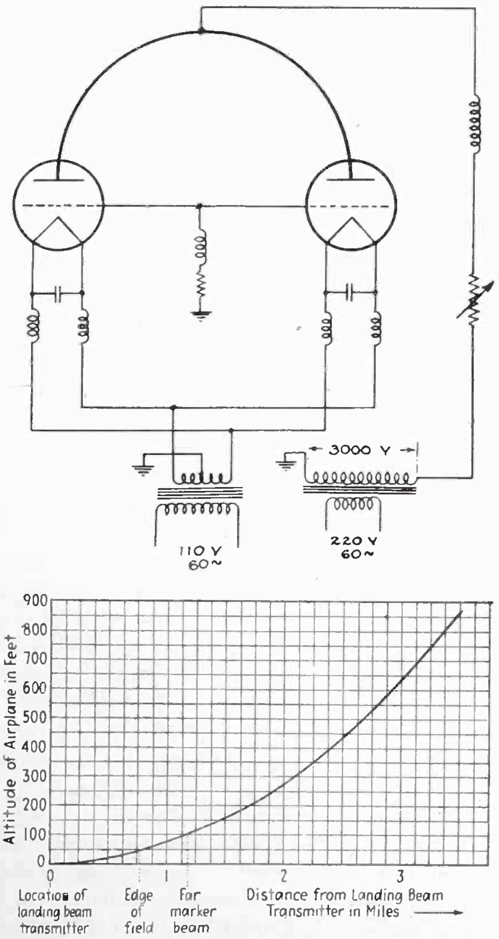

← 3000 V →
110 V
60 ~
220 V
60 ~
Altitude of Airplane in Feet
900
800
700
600
500
400
300
200
100
0
0
1
2
3
Location of landing beam transmitter
Edge of field
Far marker beam
Distance from Landing Beam Transmitter in Miles ⟶

Fig. 3—Circuit of ultra-high frequency landing beam transmitter and landing path at the Newark Airport. No variations in this path have been noted during two months of intensive tests

Absolute indication of the longitudinal position of the aircraft when near the airport is given by aural signals from two 5-watt (3,105 kc.) marker beacon transmitters in the set normally used for communication purposes. One signal (1,250 cycles) is heard when within 2,000 feet of the southwest end of the airport. The second signal (250 cycles) is received when over the field boundary. These transmitters are modulated by a ½-watt a.f. oscillator and use a power pack for 60-cycle operation. The marker beacon antennas, 2 to 6 feet high, are stretched transversely across the line of flight of the aircraft, and are of sufficient length to provide signals for all orientations of the runway beacon course. Terminating resistors (600 ohms) at each end prevent the production of standing waves along the antennas. The radiated space pattern from this antenna is sharply directive upwards, forming virtually a wall of signals through which the aircraft passes. The distance along the line of flight of the aircraft over which the signal is heard is controlled by the amount of power fed to the antenna and the sensitivity of the receiving set.

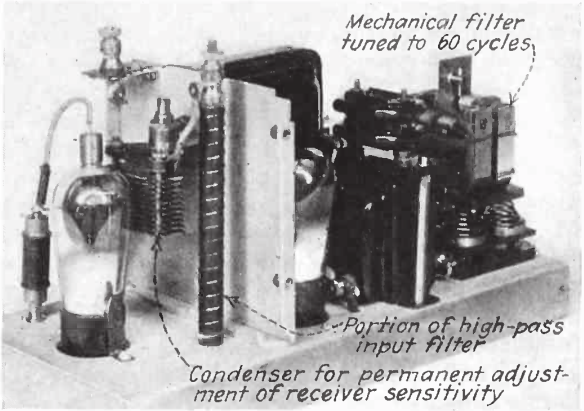

Mechanical filter tuned to 60 cycles
Portion of high-pass input filter
Condenser for permanent adjustment of receiver sensitivity

Fig. 4—Exposed view of landing beam receiving set

The high-frequency landing beam

Vertical guidance of the aircraft is given by a horizontally-polarized ultra-high-frequency landing beam (90,800 kc.), produced by two 500-watt three-element tubes operating in push-pull. The landing beam transmitter feeds a directive array which gives the necessary directivity of beam in the vertical plane, while spreading it out in the horizontal plane to afford service in the 40-degree sector between the hangar lines. The array comprises six half-wave horizontal antennas, arranged in pairs end to end, the pairs being displaced vertically by one-half wave length. The transmission line feeds all of these antennas in phase. A parasitic reflector consisting of six half-wave horizontal antennas identically arranged is placed one-quarter wave length behind the radiating antennas. There is no electrical connection between the radiating and reflecting antennas.

On the aircraft, a simple ultra-high-frequency untuned receiver without external volume control is used, fed by a transmission line from a horizontal half-wave antenna located in the wing slightly ahead of the leading edge. Permanent adjustment of its sensitivity is made by means of a condenser (Fig. 4). A high-pass filter is inserted in the detector input, while a mechanical filter tuned to the transmitter modulation (60 cycles) is in the audio output. The rectified output operates the horizontal pointer of the combined instrument in Fig. 2. The sensitivity is so adjusted that the line of constant received signal below the inclined axis of the beam, corresponding to half-scale deflection of the horizontal pointer, marks out a landing path which is suitable for the aircraft and airport considered. The horizontal index line across the face of the instrument represents the half-scale deflection and corresponds to the proper landing path shown in Fig. 1. The horizontal pointer represents the position of the aircraft relative to this path.

The point of intersection of the two pointers (Fig. 2) represents the position of the aircraft relative to the desired landing runway and to the proper landing path. Deviation from the two courses may be corrected simultaneously. By keeping the pointers crossed over the small circle on the instrument face, a suitable spatial landing path is followed down to the point of landing.

In addition to the ground equipment there is installed at the Newark Airport, in the National Guard Administration Building, a monitoring panel and a two-way communication system (3,105 kc.) so that the operator may keep in constant communication with the pilot of a landing aircraft. Assurance can be given him that the equipment is functioning properly (as seen from the monitoring panel), and that the airport is clear for a landing. Under conditions of practically zero visibility, it has proved desirable to station a man at the southwest end of the field to assist in determining that the airport is clear. Remote control junction boxes are accordingly located here to provide direct two-way communication with the landing aircraft as well as communication with the control room.

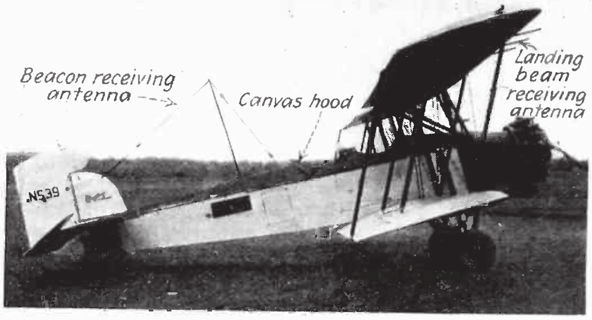


Fig. 5—Airplane used in hooded landings

The marker beacons and the communication transmitter operate on 3,105 kc. to permit use of the standard aircraft receiver and at the same time to stand by for messages from the control room. For this combined service, the receiver is equipped with a.v.c. to insure proper adjustment of sensitivity at all times. In future experiments at Newark, when a number of air transport operators are equipped to use the landing system, it is expected to change the frequency of the marker beacons to 10,000 kc. A 2-tube receiving set will then be needed on the aircraft to pick up the marker-beacon signals.

A typical flight in fog

The use of the system by a pilot attempting a landing during fog may best be outlined by an account of an actual blind flight from College Park, Md., to the Newark Airport, during which radio was the sole means used for navigation. The writer was a passenger on this flight. The ceiling was so low, upon starting from College Park, that it was found impossible to fly below it. Pilot Kinney maintained an altitude of 3,000 feet throughout the flight. No sight of the ground or sky was had except for an instant over Baltimore. Guidance from College Park to Hadley Field, New Brunswick, N. J., was obtained through the use of the aural type radio range-beacons. After passing through the "zero-signal" zone of the Hadley station, the beacon set was tuned to the Newark Airport runway beacon (278 kc.). The vertical pointer of the combined instrument showed approximately "on-course," the projection of the southwest-northeast runway at Newark being approximately over the Hadley station. The distance indicator showed the distance from Newark to be greater than 5 miles. A switch was thrown, turning on the landing beam receiving set. This completed the manipulations of radio equipment required on the part of the pilot to make use of the landing system.

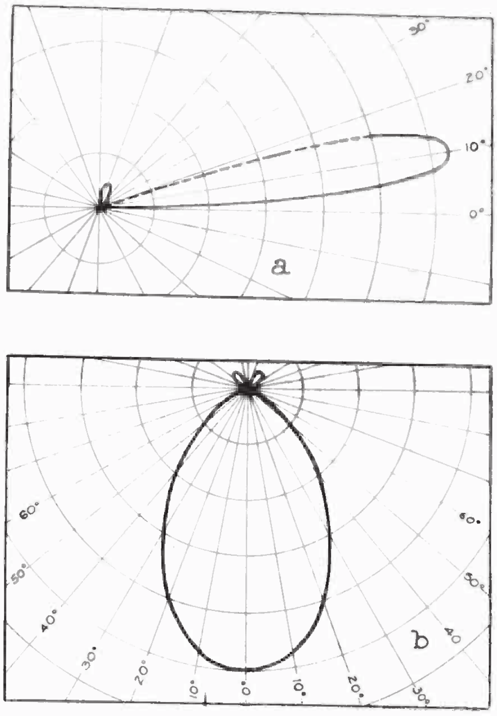


Fig. 6—Shape of landing beam (a) vertical directive pattern, (b) horizontal directive pattern

Flying at 3,000 feet the horizontal pointer of the combined instrument began to deflect, gradually reaching the horizontal "on-course" position. This corresponded to a distance of 8 miles from the landing beam transmitter, as determined from the normal landing path previously calibrated. After communicating with the airport station to determine that the field was clear the pilot maneuvered the airplane to keep the two pointers intersecting over the small circle in the center of the combined instrument dial. This gradually brought the aircraft along the runway direction and down the landing path. The distance indicator showed continuous approach to the airport boundary, and the barometric altimeter (while not sufficiently accurate for landing) showed continuous approach of the aircraft to ground. When within about 2,000 feet from the southwest edge of the airport, the high-pitched marker beacon signal began to be heard becoming most intense at 1,700 feet from the edge and receding beyond that point. At this stage of the landing the ground became visible for the first time, the aircraft being somewhat over 100 feet above ground. The pilot proceeded to land visually. Had the ground not become visible, the pilot would have continued at the same engine speed until the low-pitched field marker beacon signal was heard. He would then throttle down the engine and pull back the control stick so as to be in correct position for a three-point landing when contacting the ground.

Performance tests of the system

The demonstrations at Newark were preceded by an extensive series of tests at College Park, Md., where the practicability of the system was studied through the medium of flights and landings in an airplane equipped with a canvas hood over the pilot's cockpit (rear cockpit of airplane). Over a hundred hooded landings were made during these tests. A check pilot was used in the front cockpit to take care of faulty landings or other emergencies. The remarkable accuracy of the system was well established by these hooded landings. The landing runway at College Park is only 2,000 feet long and 100 feet wide with the approach unobstructed for a lateral distance of only 300 feet. Off the runway, the landing field is quite rough. In consequence, the runway beacon course had to be made sufficiently sharp to give appreciable off-course indications on the aircraft for deviations of the order of 20 feet (at the approach end of the field).

To utilize the course sharpness available it was found necessary to adopt a directional receiving antenna on the airplane which compensated automatically for a tendency to "weave" or "hunt" about the course and thus facilitated holding accurately to the course. The desired compensation was secured through the addition of an inclined wire running from the top of the vertical pole antenna back to the rudder fin.

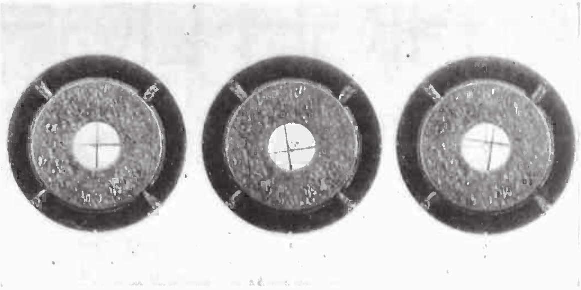


Fig. 7—Three typical course indications on combined instrument

Tests over an extended period showed the system to be inherently stable under all weather conditions. It was then decided to make an installation at Newark to determine the operation of the system under the conditions obtaining at a commrcial airport. During the two months of tests, besides making a large number of hooded landings, it was possible to fly at all times when the scheduled air mail and passenger airplanes were grounded by fog. The operation of the system was demonstrated in the air to many engineers and officials as well as to nearly one hundred air transport pilots. It is interesting to note that not even a minor adjustment of the transmitting equipment nor of the receiving equipment on the two test airplanes was required during the entire period of the tests.

Publication Approved by the Acting Director of the Bureau of Standards of the U. S. Department of Commerce.

▼ ▼ ▼

Trends in radio design and manufacturing

[*Continued from page 152*]

7. Compactness and durability. The tubes may be made much smaller than with glass envelope; and more capable of withstanding shocks in shipping and handling.

There is a strong possibility that the rapid increase in tube types may cease as a result of another English tube development which appears to simplify appreciably tube construction. Negotiations are now under way to exploit a new type of tube, already tried successfully in England, through American tube manufacturers or through a separate and new tube company set up for the purpose. More complete details of this development will be found in an early issue of *Electronics*.

Exploitation of the ultra high frequencies

Much work has been done on the development of new tubes for use on the very short wavelengths (1 meter and below). This work will be described in *Electronics* very soon. The tubes will be much smaller than conventional types, and if useful at broadcast frequencies may permit still further reduction in the size of sets.

Even with present equipment much exploitation of the 5-meter region and below is taking place. Several police radio systems have been set up on an experimental basis in the 3 to 5-meter region. These systems give complete two-way communication between headquarters and the cruisers or between two or more cars. With low power small cities can be efficiently covered. Similar equipment in a forest conservation plane has communicated successfully with the home station at distances up to 100 miles.

Sales of auto radio sets continue to set the pace for all radio. Reports indicate that dealers cannot get enough of the sets made by the well known companies. Certainly the public is auto-radio minded and if given good sets at low prices with power sources free from trouble will purchase equipment in large quantities.

Owing to the high prices asked for farm radios, and to the high plate voltage upkeep cost, this large market remains practically untapped. It seems that the engineering behind present day inexpensive auto sets could be applied to the farm radio. The rural dweller would not object to toting his storage battery to town to be charged or to charging it from his automobile generator if it provided him with a complete source of radio power—especially if that radio cost no more than a good auto set.

Raw materials and components prices

Manufacturers are hesitant to lay in big supplies of raw materials and components on the theory that prices of commodities will rise. On the other hand they are hesitant not to take advantage of present prices. And so the average maker of parts is in a dilemma. Prices indicated on page 152, obtained from prominent radio set manufacturers indicate the average prices paid during 1932. Whether these prices will decrease or rise is an open question. At the moment the trend is upward.

HIGH LIGHTS ON ELECTRONIC

Laundry conveyor operated by photocell

"We used to control the belt conveyor in our wrapping department by pushbuttons. But one of the two men employed there had to spend about half his time pressing the buttons, because the connection was such that the belt could move forward by only one compartment-length at a time while the button was held down," explains S. H. Cashman, president of the Cashman Laundry, Inc., 144th and Girard Streets, New York City. "By any other pushbutton system the operator would have had to pay too much attention to controlling the belt."

"However, the arrangement was such that if the sorting girls missed several compartments in succession, the wrapper had to push the button, wait for the belt to move one compartment and stop, then push again, and wait, and repeat the performance until a full compartment reached him.

"A photo-cell now removes this difficulty. A beam of light cuts across the belt, just at its surface, and strikes the cell on the other side. As long as nothing interrupts this beam the conveyor continues in motion. But if anything is in a compartment—even a single handkerchief—the current is interrupted and the belt stops.

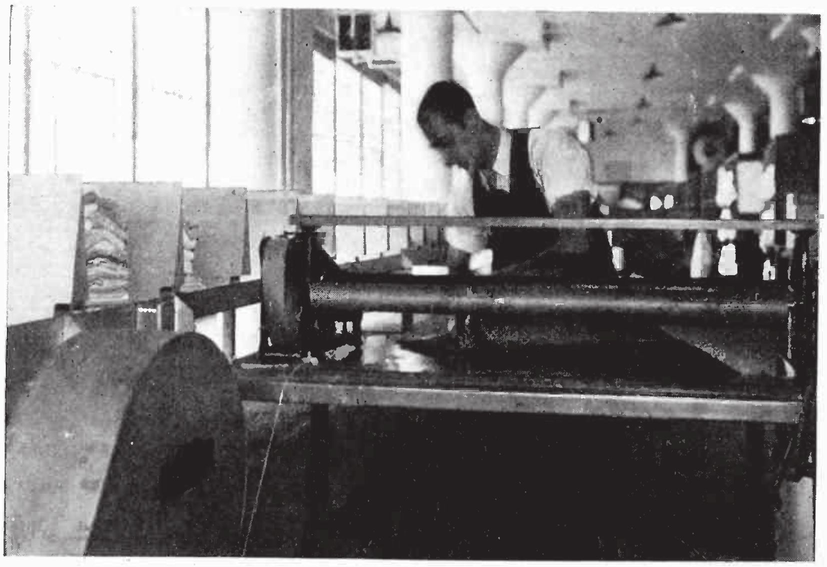
"We estimate that by relieving the wrappers of the necessity of paying any attention to the conveyor, we have speeded up their production thirty per cent," declares Mr. Cashman.

The cell control was made complementary to the pushbutton control, but did not supersede it. Thus, when a fiber sleeve obscures the light, the belt may be controlled by the button.

As long as nothing interrupts the light beam the conveyor continues in motion. In other words, the belt moves as long as the compartments passing the cell are empty. But if there is anything in a compartment a relay drops,,and the belt stops.

By means of clips properly spaced on the belt, actuating a small contactor, the cell is short-circuited while the aluminum uprights interrupt the beam, so that their cutting across the light does not stop the belt.

The cost of this photocell installation was $125. The management estimates that without it, the two wrappers could not keep up with the orders when the plant is operating at capacity. Thus, the salary of another workman, at least for part time, is saved—amounting to considerably more than $125 in a year.



At the left is seen the conveyor belt with its compartments. A light-beam and photo-cell advance the conveyor, if nearest compartment is empty.

◆

Color matching in automobile plant

The control of the color of paint for automobiles becomes a matter of considerable importance in some large plants, as different parts are finished in different places, even other factories, and later brought together for assembly. The colors must then match exactly.

A color-matching outfit that would eliminate the variables of light source and eye fatigue of the inspectors was considered advisable in the Chrysler plant at Detroit so an instrument to obtain these features was developed by W. A. Lindberg, color specialist, and E. L. Bailey, electrical engineer.

The equipment consists of a concentrated-filament 100-watt tungsten lamp with suitable reflector and condensing lens, arranged to shine on two paint panels, one the standard, the other the sample. The panels are set at 30 deg. to the light beam and 60 deg. to each other, so that the light beam is reflected off the panels at 30 deg.

Two photoelectric cells are placed facing the normal beam of light from the panels, thus avoiding the effect of reflected light from the glossy surface and receiving the stimulus for the photocells due to the color only. The photocells are connected through a potentiometer to a Weston zero-center microammeter. The circuit is so arranged that when the color of the panels is exactly alike the meter needle is in the center of the scale, and the potentiometer is also at the mid-point.

"There is another way the instrument can be used to check a color as follows," explains Mr. Bailey. "Place the standard panel in the instrument together with a neutral gray panel which is made of all colors combined. Then turn the potentiometer until a center scale reading is obtained. Now, with the same instrument setting, place the sample panel in the instrument and if the needle swings to center scale the panels match. Thus we match a sample against its standard and check the standard and sample against a neutral gray.

"The instrument seems to function consistently and without any delicate adjustments. The light source variations are almost completely balanced out by the differential connection of the cells to the micro-ammeter.

"The photronic cell of Weston company was selected for this work as it operates the meter direct without an amplifier, and also because the color response is of the same general shape as the color response of the eye. The outfit is portable and easy to operate, and, we believe, its use is a step in the right direction toward the satisfactory control of paint color specification and color in production."

◆

Infra-red fog-eye picks up ships below horizon

While in Bermuda following the cruise of the steamer Queen of Bermuda, last month, Commander Paul H. Macneil carried on six days and nights of intensive tests with the British fleet stationed there, using the "fog-eye" to detect distant ships. This instrument employs a thermo-couple which is extremely sensitive to faint infra-red rays, and through an amplifier gives an audible as well as visual signal of the presence of any object either warmer or colder than the surrounding ocean.

While results of a number of the tests undertaken for naval purposes cannot be disclosed, Commander Macneil describes two sets of experiments which show the great sensitivity of the thermocouple in its reflector mounting.

DEVICES IN INDUSTRY + +

"Detecting ship below horizon. Thirty-six readings were taken on one ship at increasing distances from one mile to 12 miles—or 6 miles beyond the horizon, the instrument being operated by three different persons during this test. The fog-eye was then mounted only 16 feet above the water: had it been higher, a much greater distance would have been possible.

This result appears definitely to prove *refraction of the infra-red rays,* opening up remarkable possibilities.

At night a small unlighted naval pinnace, whose funnel temperature was hardly higher than that of a man, attempted to approach the ship under cover of darkness and from an unannounced direction, but was easily detected at 2½ miles.

A naval plane was also detected at 4½ miles and its course readily followed.

In a letter to *Electronics,* Commander Macneil says:

"You will, no doubt, be as astonished as I was when you hear that after a sailor had accidentally dropped the amplifier on the steel deck, not even an adjustment had to be made.

"Though this instrument is only an experimental one, it was subjected to conditions that a properly designed and installed one could hardly be expected to experience, and not only was it completely successful, but has come back even more sensitive and effective than it was before the tests."

✦

Electric signs controlled by traffic lights

THE INTERESTING SUGGESTION that merchants' advertising signs be controlled by traffic lights through the medium of photo-electric cells, has been made by George Comtois of the Ray Hawley Associates, 330 West 42nd St., New York City.

Ordinary advertising signs greatly interfere with automobile drivers observing traffic signals, but by this new method the merchants' signs along the street might aid and assist the direction of traffic.

For example a big sign reading "STOP at Loft's" would be switched on when the red traffic signal is burning. As soon as the green traffic light appeared, the merchant's sign would change to "GO to Loft's."

Police authorities have usually refused to allow their traffic-control circuits to be tapped for the control of private circuits, but by focussing a photo-cell on the traffic light, the nearby signs can be synchronized with the traffic system. Mr. Comtois has notarized his proposal before a patent attorney.

Photocell insures perfect jig-saws

By Nicholas Heyman

EVEN THE PHOTOCELL contributed its share to making possible the hundreds of thousands of cardboard jig-saw puzzles which the public has been buying.

These puzzles have been presented to the public in two forms, either flat and unbroken, or broken up into pieces. In the latter case the operation of breaking, as performed by the more progressive manufacturers, is by means of a special machine into which the puzzles are fed by the operator. From this machine they pass into the box, which is then sealed and packed for shipment. Manufacturers, without exception, have found that some boxes pass through with one or more pieces missing.

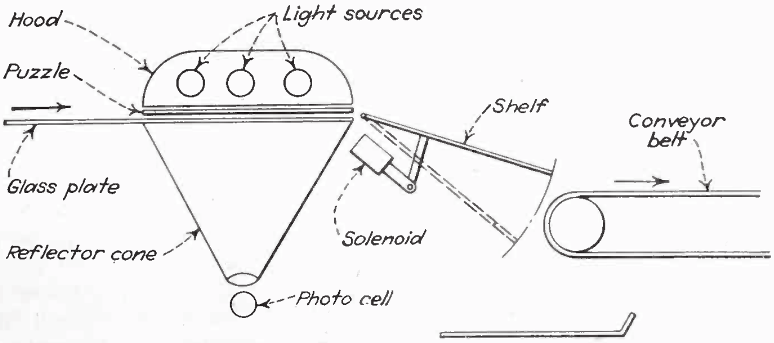
Nothing is more annoying than sitting hours trying to piece one of these puzzles together and then finding that it is incomplete. The result is loss of sales and extra cost due to replacements and adjustment of complaints. The solution to this trouble was found by one manufacturer in the application of the photocell.

When the puzzles are die-cut by means of a rule die consisting of a plywood base board in which are set the knives previously bent to the shapes of the final cut design, it is necessary to cut all pieces apart as far as possible and yet not so much so that they fall apart in handling. In other words, they must be held by small "ties" or "nics," which at least keep the pieces together until the puzzle enters the breaker. It is between this die-cutting operation and the breaking operation that one or more pieces can be lost.

Feeding the puzzles to the breaker at the rate of forty per minute does not permit the operator to inspect for missing pieces. Furthermore, when one stops to realize that these puzzles contain anywhere from 150 to 300 or more pieces, the difficulty of inspection is apparent.

The device shown in the sketch below inspected perfectly and insured for the manufacturer 100 per cent complete puzzles in every box.

The operation was as follows: A puzzle was fed under the hood, and when in position the light source was turned on. If all pieces were intact the puzzle passed on to the breaker conveyor belt. Should, however, a piece be missing, light would pass through the glass plate and the reflector cone to the photocell. This cell would in turn actuate the solenoid arranged to deflect the shelf so that the defective puzzle was diverted from passing on to the breaker. One can readily see how simple and effective this device is. For the manufacturer it served a twofold purpose. It not only insured a perfect product, but in addition impressed on his customers the important fact that "the electric eye" was on the job.



As the puzzles pass under the hood, any incomplete puzzle will allow photocell to shift the shelf, discharging imperfect puzzles below conveyor

✦

Short-waves bake crustless bread

HIGH-FREQUENCY APPARATUS of the type used to produce artificial "radio fevers" in hospitals, is now being employed to bake bread internally, that is "from the inside out" in such a way that the bread is thoroughly baked without forming a crust.

Such crustless bread is greatly desired by hotels and restaurants, which usually have to waste about one-third of ordinary bread in trimming off the crusts when serving sandwiches.

A Brooklyn bakery is now turning out experimental quantities of this new radio-baked bread which is devoid of crusts. Under the effect of the high-frequency field, currents are generated in the moist dough itself, which are sufficient to bake the bread internally, so that baking proceeds from the center outward, and no crust is formed. Thus the new radio-baked bread can be used for sandwiches without waste, and being used more efficiently, can command a higher price than ordinary bread which is one-third wasted.

The Ignitron—a new controlled rectifier

By D. D. KNOWLES
Westinghouse Elec. & Mfg. Company.
East Pittsburgh, Pa.

THE Ignitron* is the latest arrival in the rapidly growing family of industrial electronic tubes. It is a tube in which conductivity is established by igniting the arc in much the same manner that an explosion is ignited in the cylinder of an automobile engine. The advantages of such a device cannot be adequately appreciated without first reviewing the properties of other tubes that are now used.

The most familiar type of controlled tube is the ordinary high vacuum amplifier, such as used in radio receivers. Tubes of this type have been developed to carry currents up to several hundred milliamperes[1] and with characteristics and life that make them very valuable in industry. Although the comparatively small capacity of these tubes does not bring them into the class of power apparatus, they serve a very useful purpose nevertheless in sensitive circuits, linear amplifiers and as accessories to high power tubes.

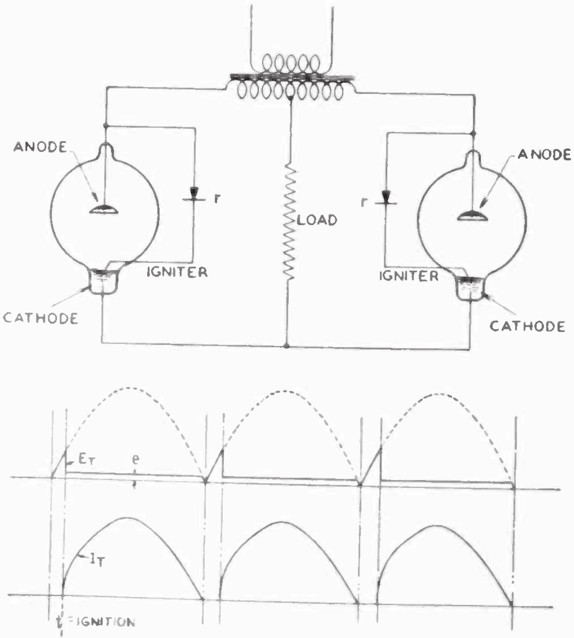


Fig. 1—Full wave single phase rectifier using the new tubes

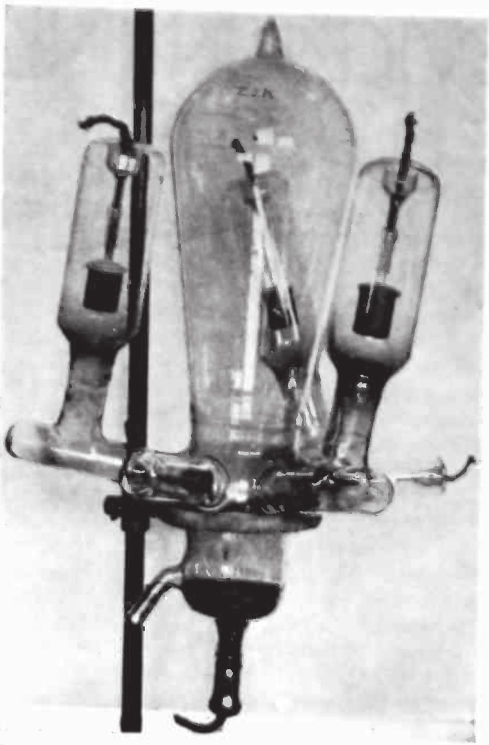


Fig. 2—A three-phase mercury pool rectifier of conventional type

Within the last few years many types and sizes of grid-controlled gas and vapor tubes have been introduced under the trade names Grid-Glow Tube[2], Thyratron[3], Trianode, Kathetron[4], etc. These tubes utilize a gas or vapor which ionizes under impact by electrons, and the resulting ions reduce the space charge limitations inherent in high vacuum tubes. As a result, tubes of this type have been made to carry several hundreds of amperes and are, therefore, power devices.

Their field of usefulness is very great, and there is little doubt that the next few years will see more and more of them used for the control and conversion of electric power. They do, however, have certain specific limitations that can best be illustrated by describing a typical tube. This tube will contain an oxide coated cathode which is the electron emitter, an anode which collects the electrons and a grid which controls the discharge. To provide the necessary gas or vapor for ionization a small globule of mercury which will vaporize and give an atmosphere of mercury vapor at the desired pressure is introduced into the tube.

The cathode limitations

A time delay in starting is essential in order that the cathode shall reach operating temperature before current is drawn. This delay may be only two or three seconds for small tubes or as much as an hour for very large tubes. The disadvantage of such a delay is obvious. Indirectly, this feature introduces a less obvious but nevertheless serious difficulty in those applications where it is not permissible to have power interruptions; for example, in inverters or rectifiers feeding industrial or domestic power systems. In such instances spare tubes must be kept in readiness in case of tube failure, and to avoid delays the cathodes must be kept energized.

Another serious limitation results from the fact that the cathode has a fairly definite capacity to emit electrons and that any current in excess of that value will damage the cathode to an extent depending on the amount of overload and the time that the overload exists. This property makes it impossible to design an efficient tube that will have a satisfactory overload rating.

Therefore the cathode introduces three principal limitations: 1. Power losses; 2. Time delay in starting; 3. Low overload capacity.

As previously mentioned, mercury vapor is used to provide ions for space charge reduction. There are several reasons why mercury is used instead of other gases or vapors.

1. It is a heavy material so that a positive ion formed in the discharge will remain there for a relatively long time and thus counteract the space charge effect of many electrons. This results in a marked decrease in the number of ions striking the cathode per second and a consequent increase in tube life.

2. The ionization and resonance potentials of mercury are low so that the tube drop is also small. This is obviously desirable from an efficiency standpoint, and furthermore it prolongs the cathode life by limiting the energy of the ions striking the cathode.

3. Being volatile at tube temperatures it furnishes an inexhaustible supply of vapor which will not clean up in the discharge. It introduces, however, a temperature effect which is often objectionable. As the tube temperature is changed, due to variations in ambient temperature, cooling, or tube load, the vapor pressure is altered and the grid control characteristic changes.

Tubes with other gases, such as argon, neon and helium are free from temperature effect[5], but other factors enter that limit their use to small tubes.

In a grid controlled gas or vapor tube the grid is called upon to prevent or hold back a discharge, which in the absence of a grid, would start at a very low potential. Not only would it start at a very low potential, but it would start in an extremely short time, say one to 25 microseconds. Due to the properties of an arc, the discharge, once it has started, cannot be extinguished except by removing the potential at least for a short time. We thus have a kind of switch which will close instantly unless held open, and once closed can only be opened by removing the potential. In the case of a.c. this occurs at the end of each half cycle.

In many respects this characteristic is very desirable, and in others, it is a severe handicap. For example, in a parallel type of inverter for changing d.c. into a.c., the potential is removed from the conducting tube for only a short time. During this time it is imperative that the tube extinguish and the grid regain control and retain it until time for it to start again. If for any reason during the insulating period the grid relinquishes its grip even for a microsecond or so, the tube starts and in general will throw the inverter out of service.

We see, therefore, a definite need for a tube which will remain non-conducting until *made* to start instead of one that is non-conducting only so long as it is *prevented* from starting.

Further requirements for an ideal tube of this type would include: 1. Instant starting—no delay when put into service; 2. High overload capacity; 3. Long life; 4. Efficiency.

Slepian and Ludwig[6] have described a new method for initiating the cathode of an arc which consists in immersing certain materials, such as a carborundum crystal, in a mercury pool and then passing current from the crystal to the mercury. At a definite value of voltage and current, a tiny spark appears at the junction and immediately grows into the cathode spot of an arc. If an anode properly spaced is held at a positive potential with respect to the arc, the latter will transfer very quickly to the anode and the relay or switching action is complete. This whole mechanism may occur in only a few microseconds. Figure 1 shows a simple diagram of such a tube and circuit for full wave single phase rectification. The two waves shown illustrate the voltage E_T across the tubes and the current I_T through the tubes, assuming a resistance load and neglecting the current taken by the igniter itself. The igniter current is approximately proportional to E_T.

A new tube—the Ignitron

The operation of such a circuit is very simple—starting at the beginning of the voltage cycle, the current and voltage increase along the wave E_T until at the instant the spark occurs. The cathode spot forms immediately and the anode which is positive picks up the arc. The rectified current I_T flows for the balance of the cycle accompanied by a constant voltage drop e of about 10 volts. At the end of the cycle, the arc goes out and on the inverse cycle, the small rectifiers r prevent reverse current and consequent heating in the igniters.

What are the advantages of such a rectifier? As compared to the hot cathode type previously described, it requires no delay when placed in service; it has a high overload capacity and longer life.

The features of long life and overload capacity can, of course, be obtained with the conventional mercury pool rectifier but only with greater complication or tendency to arc back. To be more specific, each pool cathode in the conventional rectifier requires a starter of some kind to form the arc and a keep-alive transformer and reactor to maintain the arc at all times. To insure stability, at least 5 amperes are necessary in the keep-alive circuit. This consumes energy which is wasted, and what is even more serious, in a single anode tube, produces ionization during

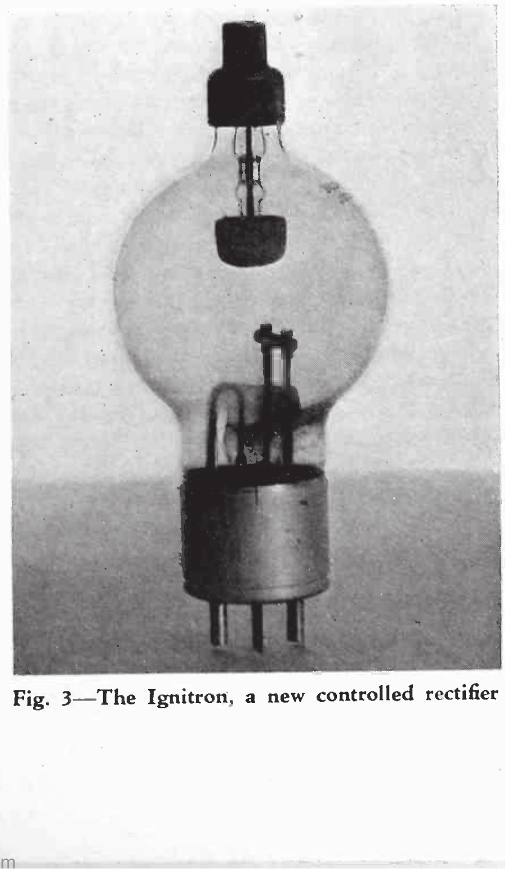


Fig. 3—The Ignitron, a new controlled rectifier

the inverse cycle, thus increasing the tendency to arc back. To prevent arc backs, the anodes are placed out in anode arms and since each pool requires expensive keep-alive equipment, they are usually combined into one to serve from two to twelve anodes.

Figure 2 shows a three phase mercury pool rectifier of the conventional type, and Fig 3 one of the new Ignitrons.

Since the Ignitron starts at the beginning of each conducting half cycle, we require no starter, and since there is no arc during the inverse cycle, there are no anode arms. Three such tubes will replace such a conventional rectifier with less auxiliary equipment, lower replacement cost and with better performance.

There are many applications, such as motor speed control, theater light dimming, voltage regulation, etc., in which the output of the rectifier must be varied. This can be accomplished with Ignitrons by shifting the phase of the control voltage.

Figure 4 shows such a circuit feeding the armature *A* of a d.c. motor for variable speed control. A single Ignitron is shown for simplicity, though in general, full wave rectification would be used.

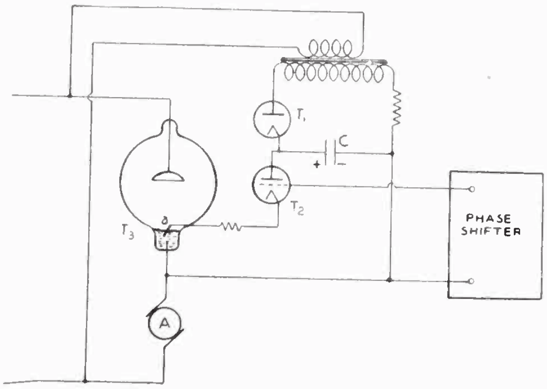


Fig. 4—Use of Ignitron for variable speed control

In connection with this circuit, it should be explained that at the present stage of development the instantaneous current required by the igniter to start the arc reliably is from 5 to 30 amperes. This does not represent much power, however, in view of the fact that it need last but a few microseconds. In other words, the requirements are very much the same as for gas engine ignition.

In Fig. 4 the condenser C is charged with the polarity shown during the half cycle of inverse potential on the Ignitron. The rectifier T_1 prevents this charge from reversing on the next half cycle during which the grid-glow tube T_2 is biased to break down and discharge the condenser through the igniter electrode (a). The point on the cycle at which this occurs may be varied by adjusting the phase of the grid voltage on the grid-glow tube. The average rectified output of the Ignitron is thus varied in the well-known manner from a small value corresponding to breakdown at the end of the half cycle to a maximum value corresponding to breakdown at the beginning.

When Ignitrons are developed as they inevitably will be, to operate with control currents of an ampere or less the phase control circuit of Fig. 4 can be considerably simplfied by the omission of the auxiliary tubes T_1 and T_2 as well as the condenser. The output of the phase shifter would be applied directly to the igniter electrode with a small copper oxide rectifier, for example, to prevent back current through the igniter on the inverse cycle.

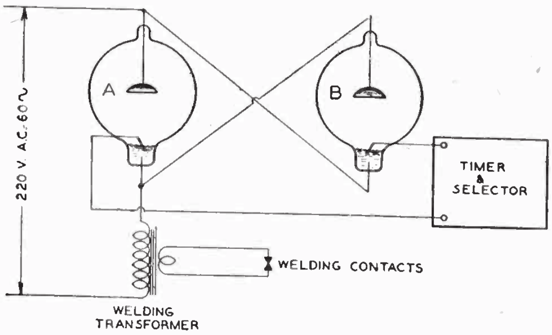


Fig. 5—High speed, high current spot welder controlled by the new tube

It is frequently very difficult or impossible to make mechanical contactors and circuit breakers for very large capacities and with the desired speed. An example of such a requirement is in high speed spot welding, where an a-c current of several thousand amperes may be required for as short a time as one-half cycle. Here again is an opportunity for the Ignitron. It may be started in a time which is short compared to a half cycle and by its very nature extinguishes completely at the end of each half cycle. The fact that the mercury pool has an average current rating instead of a crest current rating makes it possible to handle such high currents with ease.

Figure 5 shows a simplified wiring diagram of a welder, the details of timing etc. being omitted for clarity. Two Ignitrons are used (A and B) one for each half cycle of the a-c power and are connected in series with the primary of the welding transformer. The number of half cycles are pre-selected by the timing mechanism and the Ignitrons do the rest.

The examples given serve only to illustrate the field of usefulness that tubes constructed on the ignition principle promise to fill. Considerable remains to be done on the development of the igniter electrode itself before the ideal tube characteristic is approached. This problem is not a simple one as shown by the following requirements.

1. It must be a highly refractory material to avoid being damaged by contact with the arc.
2. It must not decompose or otherwise give out gas during operation.
3. It must not be wetted by mercury as this would short circuit the electrode.
4. It should have a resistivity of 0.04 ohms per cubic inch or more.
5. It should be mechanically strong.

The author does not wish to leave the impression that the Ignitron will completely replace grid control tubes. Both have their respective advantages, the decision usually resting on the importance of time delays, efficiency, life, sensitivity and overload capacity.

In closing, the author wishes to thank Messrs. Stoddard, Smede, Bangratz and Berkey for the use of data, photographs, etc., and Dr. Slepian and Dr. Ulrey for helpful suggestions.

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*Pronounced like the word "ignite."

[1] A New Industrial Amplifier Tube, L. Sutherlin, *El. Journal,* March 1932, p. 139.

[2] The Theory of the Grid-Glow Tube, D. D. Knowles, Part I. *El. Journal,* Feb. 1930, p. 116; Part II, *El. Journal,* April 1930, p. 232.

Grid-Controlled Glow and Arc Discharge Tubes, Knowles and Sashoff, *Electronics,* July 1930, p. 183.

[3] Hot Cathode Thyratrons, A. W. Hull, Part I., *G. E. Review,* April 1929, p. 213; Part II., *G. E. Review,* July 1929, p. 390.

[4] The Kathetron, Palmer H. Craig, *Electronics,* March 1933, p. 70.

[5] The KU-610 Grid-Glow Tube., R. K. Gessford, *El. Journal,* July 1932, p. 351.

[6] Presented at the Winter Convention of the A.I.E.E., New York N. Y., January 23-27, 1933.

Suppression of transmitter harmonics

By CARL G. DIETSCH
National Broadcasting Company

IN CONSIDERING the proportionate band width of the radio frequency spectrum within which interference is liable to occur due to the radiation of harmonics by transmitting stations it is apparent that this band includes all but a very small fraction of 1 per cent of all the channels at present available. With the assignment of more stations to operate within the spectrum and the general use of higher power the problem of harmonic suppression has become rapidly more important. Design requirements of a modern transmitting station, therefore, point not only toward adequate frequency stability and a minimum of adjacent channel interference, but also toward the suppression to the highest degree of radiation of all spurious frequencies, particularly of a harmonic or parasitic nature.

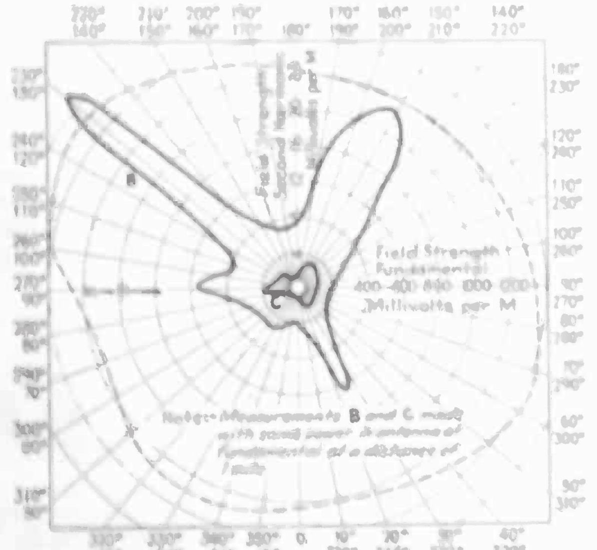


Fig. 1—Radio field intensity survey. The dotted curve gives fundamental frequency field strength; B and C are second harmonic intensity before and after reduction

This has presented a difficult problem in so far as vacuum tube transmitters are concerned since it is the inherent characteristics of a vacuum tube while functioning at a reasonably high efficiency in an amplifier circuit to become a very effective generator of harmonics. Vacuum-tube transmitters are the frequent source of such interference. The extent to which the interference becomes objectionable depends not only upon the amount of power a given vacuum tube generates at harmonic frequencies within an amplifier circuit but also how effectively it is radiated from the station.

Since the only method of determining how effectively a station radiates power is by means of a field intensity survey, it is evident that if it is desired to suppress harmonic radiation to an absolute minimum, such field measurements are indispensable. While circular surveys of field intensity at various angles between the horizon and the zenith is a difficult procedure, a survey made in the plane of the earth's surface is valuable since low angle radiation is apparently very effective even at the higher frequencies.[1] Some of the results of work performed along these lines by the Radio Engineering Department of the National Broadcasting Company under Mr. Raymond Guy are illustrated in the polar curves of Fig. 1. These curves show the results of a survey taken near a high-powered broadcasting station.

In specifying allowable harmonic radiation from a broadcasting station, the IRE Committee on Broadcasting[2] has recommended that the maximum radio field intensity of a harmonic component measured at a distance of one mile from a station should not exceed 0.05 per cent of the field intensity of the fundamental. A field strength of 500 µv./m at a distance of one mile is recommended as a maximum allowable intensity from a high-powered transmitting station. If in the case of a 50-kw. station a circular field pattern and equal attenuation is assumed for both a harmonic and the fundamental in the immediate vicinity of the station, a field strength of 500 µv. at one mile would correspond to approximately seven milliwatts of radiated power at a harmonic frequency.[3] The effect of directivity (illustrated in curve *B*), may cause a field intensity of a number of times the value of 500 µv. to be projected in a given direction with a very small fraction of one watt of harmonic power in the transmission line and antenna circuits. Such a concentration of radiated power may form very objectionable interference. Considering the factors involved therefore, it is evident that harmonic suppression must be attacked from a number of angles. These may be briefly outlined as follows:

1. Design of the transmitter circuits to reduce the harmonic content of the power delivered to the antenna circuits to a minimum.
2. Thorough and effective shielding of the entire transmitter or building.
3. Effectively grounding all harmonic drain circuits and elimination of long conductors near the transmitter coupled to it inductively or capacitatively.
4. Reduction of directivity of harmonic radiation to a minimum.
5. Installation of shielded band or low pass filters at the input end of the transmission line, to the antenna.

Some commonly used triode amplifier circuits are shown in Figs. 2 and 3. The push-pull amplifier is superior to the single-ended circuit as it is capable of producing a sum plate current of the two tubes which is symmetrical in waveshape and therefore containing no even harmonics.[4] Individual plate currents, of course, contain even harmonics which are drained to ground

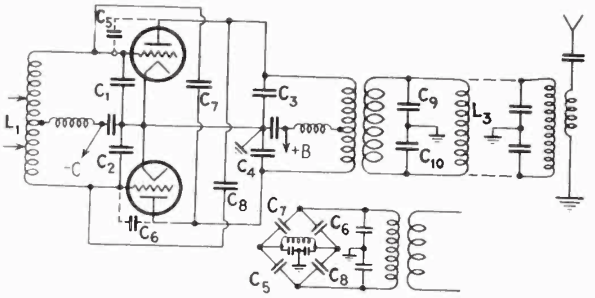


Fig. 2—Push-pull amplifier with high kva. tank circuit in transmission line

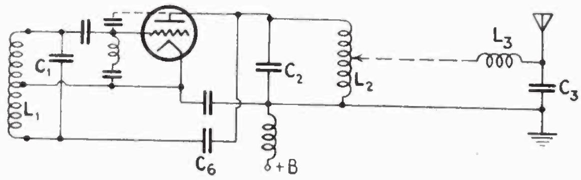


Fig. 3—Line termination effecting reduced harmonic radiation

through C_3 and C_4 resulting in identical instantaneous even harmonic potentials being set up on each side of L_2 but no actual even harmonic current through it. Under these conditions, an electrostatically shielded inductive coupling permits transfer of only fundamental and odd harmonic frequencies to the coupled circuit. For a condition of symmetrical plate current it is evident that the tube characteristics must match closely, $C_1 = C_2$ and $C_3 = C_4$. The neutralizing bridge must be balanced not only for the fundamental frequency but for even harmonics. This requires that the internal capacities of the tubes should match. As will be shown later, a high ratio of circulating kva. in the tank circuit to the kw. delivered from the amplifier reduces the output of harmonics from a single-ended amplifier to a very low value. This is also true in the push-pull circuit.

The circuit shown in Fig. 3 will give a very small amount of harmonic output by proper design of the circuit constants. The curves in Fig. 5 show the filtering effect of a high kva. tank circuit in suppressing harmonic components of current generated in the tube. These curves show actual harmonic transferred to a given load circuit Z_L with a constant output at the fundamental and various kva/kw. ratios of L_2 and C_2. Fig. 4 shows improvement in tank circuits so as to increase the normal filtering action of an ordinary tank circuit. A high kva/kw. radio applied to these circuits is capable of reducing harmonic output to an extremely small amount. There are some limitations in the amount of filtering which can be secured by a high kva. tank circuit, however, since the I^2R losses in the circuit increase in proportion to the circulating kva. and the cost of apparatus for increasing kva. in a circuit without increasing losses is considerable. In broadcasting transmitters there is the limitation of too low a decrement in a circuit attenuating too greatly the high frequencies of a modulated envelope. In Fig. 4 the series of trap L_3C_3 is tuned to a particular harmonic to be eliminated. The use of antiresonant circuits (parallel traps) in the plate lead of an amplifier while reducing to some extent a single harmonic has a tendency to allow considerable voltage to build up at others. Most satisfactory results are usually secured by designing a minimum impedance path for harmonics to ground as compared with a given high impedance at the fundamental.

The effectiveness of the shielding of a transmitter may be determined by operating the transmitter with full power output into a shielded phantom antenna. Measurement of the harmonic field strengths produced from the transmitter itself is direct evidence of how well it is shielded. Such radiation can be usually traced to a long conductor near the transmitter coupled to it through a common ground return or capacitively. Ground conductors serving to drain harmonic frequency power to ground therefore should be as direct as possible and should not be extended so as to have a free end which might attain a high potential at resonant frequencies. This is particularly true of the harmonic drains near the antenna itself. These should have a separate ground to prevent coupling of harmonic frequencies into the antenna.

A sensitive wavemeter is very useful in determining the relative harmonic field intensities near the various circuits of a transmitter. When tuned to the frequencies of various harmonics, and coupled to various circuits of the transmitter or placed at positions along nearby open conductors, this instrument will indicate proportionate amounts of the harmonic components of the current flow. By effectively grounding a long open conductor either directly or through large capacity condensers at a number of distributed points harmonic radiation can usually be eliminated.

The push-pull amplifier when coupled to a long transmission line has often become a source of undesirable even harmonic radiation because of sufficient electrostatic capacity existing between the coupled circuits to permit a transfer of even harmonic energy from the amplifier output circuit to the line. Unless this electrostatic capacity is reduced to an extremely low value, i.e., by installation of a well-grounded electrostatic screen, between the two coils, even harmonics usually find a path along the transmission line with a ground return to the generating source. An unshielded transmission line serves in this case as an effective directive radiator[5] in the form of a large loop. Its effective height

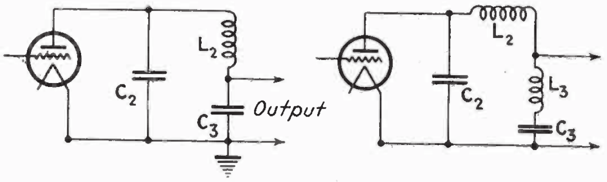


Fig. 4—Improved tank circuits for suppressing harmonic radiation

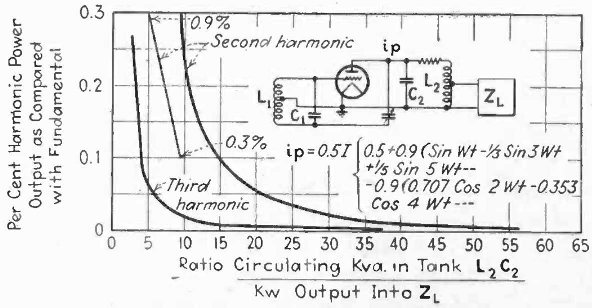


Fig. 5—Effectiveness of high kva.-kw. ratio in reducing harmonic output with constant power output at fundamental

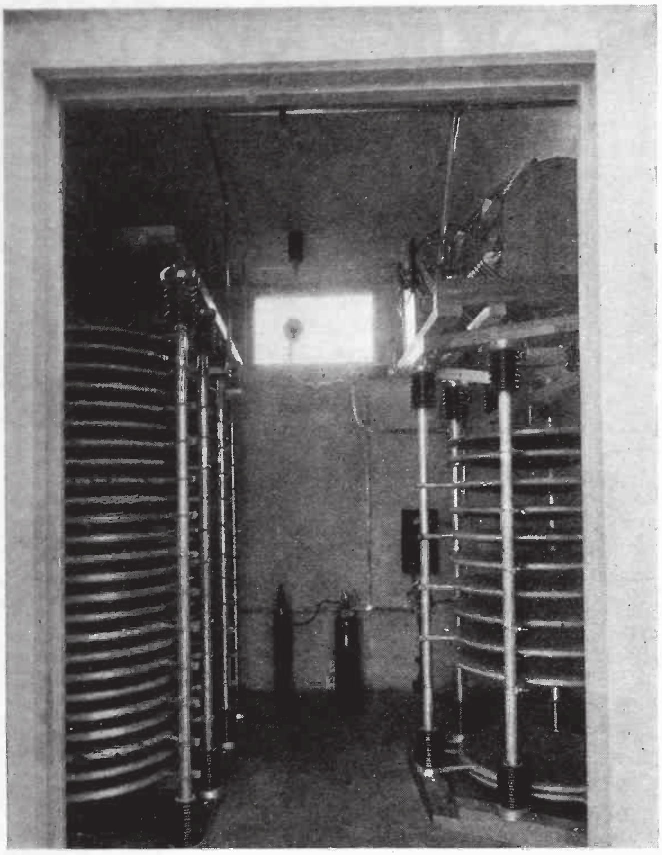


Fig. 6—Harmonic suppressing equipment in field installation of high powered broadcasting station

will be dependent upon the height of the transmission line above ground. Parallel flow of even harmonic currents along the line, therefore, makes it a much more effective radiator in some directions than the push-pull flow of harmonic currents in the line.

A circuit which has been found to be very effective in reducing both the parallel as well as the push-pull flow of harmonic currents in a transmission line is shown in Fig. 2 in the form of a high kva. floating tank circuit $L_3C_9C_{10}$ tuned to the fundamental component of current flowing in the line. This tank circuit, while offering an impedance to the fundamental approaching an infinitely high value, offers a relatively low impedance path to ground for the parallel flow of even harmonics equivalent to

$$Z_{ne} = \frac{-1}{4 \pi f_{ne} C_9} = \frac{-1}{4 \pi f_{ne} C_{10}}$$

where: resistance of circuit is negligible

Z_{ne} = impedance to n^{th} even harmonic
f_{ne} = frequency of n^{th} even harmonic

and for the push-pull flow of odd harmonics between transmission-line conductors

$$Z_{no} = \frac{-2 \pi f_{no} L_3}{(2 \pi f_{no})^2 L_3 C - 1}$$

where: resistance of circuit is negligible

Z_{no} = Impedance to n^{th} odd harmonic
f_{ne} = Frequency of n^{th} odd harmonic

$$C = \frac{C_9}{2} = \frac{C_{10}}{2} \text{ where } C_9 = C_{10}$$

It is evident that as C_9 and C_{10} are increased in capacity the effectiveness of the circuit in reducing harmonics is increased. Since the transmission line termination impedance is usually made to match the line impedance[6] for the fundamental frequency it usually happens that the line impedance is matched for this frequency only and as a result harmonic components of current and voltage in the line appear as standing waves along the line. In such a case the above tank circuit is most effective for eliminating a particular harmonic if it is placed at a point along the line of maximum voltage. This circuit alone was effective in one case in reducing second harmonic radiation from a station to one-fifth of its former value.

Antiresonant circuits installed in a transmission line at current antinodes have been found very effective in reducing to a great extent a single harmonic to which they were tuned. Extreme care should be taken in shielding these antiresonant circuits to secure best results. A combination of antiresonant circuits and a low pass filter is shown in Fig. 7. This combination has been used successfully in severe cases of harmonic radiation from a very long transmission line and antenna system. The filter in design matches the surge impedance of the line and has a cut-off frequency between the fundamental and second harmonic. Antiresonant circuits have been found useful to sharpen the cut-off so as to attenuate sufficiently the second harmonic frequency. Considerable experience in filter design and adjustment is required to secure optimum results from such an arrangement.

The methods of line termination shown in Figs. 2 and 3 are effective in reducing the possibility of harmonics reaching the antenna circuit. The termination shown in Fig. 3 may be improved by use of a multi-section low pass filter.[7]

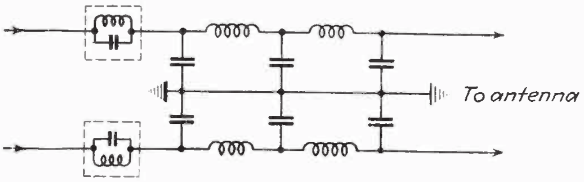


Fig. 7—Low pass filter combined with antiresonant circuits in transmission line

While it has not been within the scope of this article to discuss in length all of the methods used by the Engineering Department of the National Broadcasting Company in effecting reductions of harmonic radiation from various of its 27 stations, the above methods and results are mentioned because of their merits. Considerable work has been done along these lines to bring old types of transmitters up to present standards of the National Broadcasting Company.

[1] *Proceedings IRE* Oct. 1931 "Development of Antennas"

[2] *Proceedings IRE* Jan. 1930.

[3] At very high frequencies ground waves are attenuated rapidly. In estimating relative amounts of radiated power required at two different frequencies to produce equal field strengths at a certain distance the actual attenuation of both frequencies must be known. Refer to Bureau of Standard-Journal of Research, April 1932, page 432.

Modern transmitters made by leading manufacturers have a radiation of harmonic power of the order of not over $14x10^{-6}$% of the fundamental power.

[4] Malti, "Electric Circuit Analysis," page 172.

[5] *Proceedings IRE June, 1923.* F. W. Dunmore.

[6] In the case of a parallel wire transmission line this is equal to $Z = 276 \log_{10} 2D/d$ where D = distance between centers of conductors and d = diameter of conductors.

[7] *Proceedings IRE June 1931.* "Suppression of Radio Frequency Harmonics in Transmitters." Labus & Roder.

+ + ELECTRONIC NOTES

Simultaneous traces with cathode-ray oscillograph

By C. Bradner Brown

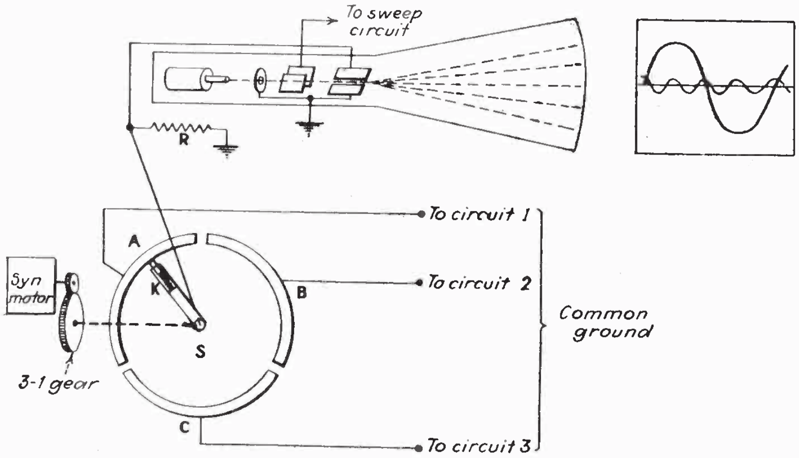
One of the main disadvantages of the cathode-ray oscillograph is its inability to produce simultaneous traces. This lack of flexibility forces the research worker to turn to either the mechanical oscillograph or to photography to obtain wave forms or traces in their proper respective positions on the same record. The mechanical models overcome the simultaneous tracing problem by mounting three separate tracing units in such a position that all three operate on the same screen. The use of separate tracing elements is highly satisfactory, but the production of a cathode-ray tube having three electron streams is out of the question, not only from an economic standpoint, but also from a portability standpoint. The main advantages of the cathode-ray oscillograph lie in its complete portability and simplicity in action together with the exact reproduction obtained. A cathode-ray tube having a multiplicity of tracing elements would greatly limit its scope of usefulness on account of the increase in bulk.

The system devised by the author for the study of simultaneous traces does not in any way interfere with the operation of the cathode-ray tube and is simply an auxiliary piece of equipment. It consists mainly in a mechanical switch for changing the cathode-ray deflection plates from one potential source to another in rapid succession. The system was so designed that it would complete a cycle of operations in a time short enough to make use of the phenomena of visual persistence to obtain a complete set of traces. The circuit is shown in schematic form in the figure. The rotary switch *S* having three contact segments and a wiping arm driven by a synchronous motor operates at 600 r.p.m., causing it to repeat the cycle of operations 10 times a second. The eye will therefore retain any impression received during one revolution of the switch, the action of which is as follows:

During the first third of a revolution, the arm *K* is connecting segment *A* to the deflecting plates, which causes the electron beam to trace the voltage form of circuit 1. A thirtieth of a second later, the arm *K* has moved around and connected segment *B* to the deflecting plates, causing a new wave form to be traced on the screen. During the last third of the revolution, *C* is connected to the tube, and since all three traces have been made in less than a tenth of a second, the eye receives the impression of three separate traces on the fluorescent screen.

In the experimental model, an Allen B. Dumont, model 34 cathode-ray tube was connected to a conventional sweep circuit for the production of a linear time axis. The amplitude deflecting plate was connected to the rotating arm, one side being a common ground. The resistance *R* prevents any charge from collecting on the deflecting plates during the brief time when the rotating arm is between segments and not connected to anything. The rotating arm *K* was driven through a 3-1 gear at 600 rpm by a Bodine model NSY-12 1/150 hp. synchronous motor operating at 1,800 rpm. This assured an evenly-timed reproduction of the three traces and eliminated the problem of speed control of the switch mechanism. The switch itself was constructed of bakelite and the segments *A, B* and *C* were inset in such a manner that the wiping contact ran smoothly over the joins.

The advantages of the system were at once apparent. The new arrangement allowed the use of a standard frequency wave form for comparison purposes. Not only could the frequency of the unknown wave be rapidly determined, but any deviation from a sine form could be easily distinguished and checked. If the third segment were kept at ground potential, an axis line was traced which allowed the comparison of amplitudes, positive and negative, thus showing any distortion with reference to the axis. It proved particularly valuable in the study of phase shift in electrical equipment, as both the original and shifted wave could be compared and the shift measured quite accurately.

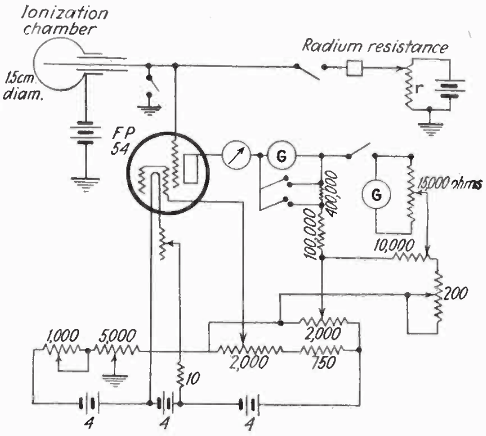


Device for tracing more than a single wave shape on a cathode-ray tube

◆

Measuring the intensity of 700 Kv. X-rays

A large portion of the March number of the *American Journal of Roentgenology* is devoted to the discussion of the relative effects produced by 200 kv. X-rays, 700 kv. X-rays and gamma-rays, as studied at the Biophysical Laboratory of the Memorial Hospital, New York City. In view of the ionization chambers which had to be used a very sensitive instrument was required for measuring the conductivity produced by the rays. A vacuum tube instrument proved to be satisfactory for the task. It consists of two parts, a lead box containing the vacuum tube FP-54, the high resistor (a radium preparation and air gap and the grounding key of lead. The ionization chamber traversed by the X-rays is attached to the bottom of this box by means of its highly insulated stem. Batteries, rheostats and meters are placed outside the roentgen room and connected by wires under lead covers.



Use of the FP-54 for measuring ionization currents

Another practical vacuum tube circuit for measuring the electro-motive force of high resistance sources is described in *Res. Scient. Instr.* 4:131-137, 1933.

FROM THE LABORATORY ++

Comparison of photocells

THE FOLLOWING TABLE giving the comparison of merit of the three types of light responsive cells is taken from a paper by A. J. McMaster, delivered before the Radio Engineers Club of Chicago.

The *photo-emissive cell* is in most general commercial use for the following reasons:

1. High red sensitivity.
2. Stability.
3. High impedance resulting in large voltage signal when used with electronic amplifier tubes.
4. Linearity of response.
5. Good dynamic response.

Its principal limitations are:

1. It generally requires amplification in relay equipment.
2. It requires an operating potential of 50 volts or more.
3. Operating current should be limited to not more than 50 microamperes—generally less.

The advantages of the *photo-conductive cell* are:

1. Some types can be made very sensitive to infrared light.
2. Some types have large current output (with low sensitivity).
3. Some types have high sensitivity with low current.
4. Can be operated at low voltage.
5. It has good response in all parts of the visible spectrum.
6. It has a considerable temperature coefficient.

Its disadvantages are:

1. Some types are unstable.
2. It has a rather high dark current.
3. Its time lag is great and dynamic response is poor.
4. It is critical with respect to operating voltage.

The advantages of the *photo-voltaic cell* are:

1. It operates without external source of voltage and is particularly suitable for portable use or installations where 110 volt power is not available.
2. Can be used with relays without amplification if sufficient change in light intensity is available.
3. Two or more cells can be conveniently used in parallel or series.
4. Relatively large output currents can be obtained with sufficient light intensity.
5. Some types are stable over long periods.
6. Color response is similar to that of human eye.

The limitations of this type are:

1. Its output cannot be conveniently amplified by vacuum tube methods.
2. Its dynamic output is very poor.
3. Since the output cannot be efficiently amplified when used with relays, the relays required are of low torque (resulting in low contact pressure and relatively slow speed of operation) and are expensive.
4. For relay operation relatively large changes in illumination are necessary.
5. It has a considerable temperature coefficient.
6. Ambient temperature range is somewhat limited.
7. It has appreciable lag of response in quantitative measurements.

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Measuring one billion ohms

By Dr. Irving J. Saxl*

FORMERLY THE USE of a few hundred volts was necessary in the measurement of resistances amounting to a billion ohms. This was practically the limit to which resistance measurements could be brought, using Ohm's law and the most sensitive type of galvanometers. In addition, due to the small damping of these suspension galvanometers, these measurements needed an appreciable amount of time.

Now, with an amplifier using the General Electric tube FP-54, it is possible to measure resistances of a billion ohms, with only about one volt impressed.

This new four-electrode tube which makes possible the measurements of currents down to 10^{-17} amperes has already been described in *Electronics*. This makes possible the exact study of highest resistances, to improve the insulating properties of various materials, exact astronomical determination of the light of distant stars, the measurement of cosmic rays, of radium and X-ray emanations.

The new amplifier is compact, portable and easy to use. The control grid is insulated from the rest of the tube elements, by fused quartz inside of the tube. The external control grid circuit must be equally well insulated and care must be taken in the selection of the high ohmic resistors.

The tube is designed to be operated at low voltages and to have very small control-grid current. This is of the order of 10^{-15} amperes. The control-grid resistance is about 10^{16} ohms.

In combination with a commercial type of galvanometer, this supersensitive amplifier makes possible the exact measurement of currents as small as 10^{-15} amperes. When used with a suitable sensitive galvanometer this range may be extended to 10^{-17} amperes.

So sensitive is the device that a person moving about the room would produce readings greater than those of the input circuit, were the amplifier not properly shielded. It is enclosed therefore completely in a metal box, only the two shafts of the two controls coming out on its metal panel.

The circuit is a modification of the Wheatstone bridge, with the plate resistance of the tube serving as one of the legs. A 12-volt storage battery is required to operate the tube.

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*Consulting Physicist.

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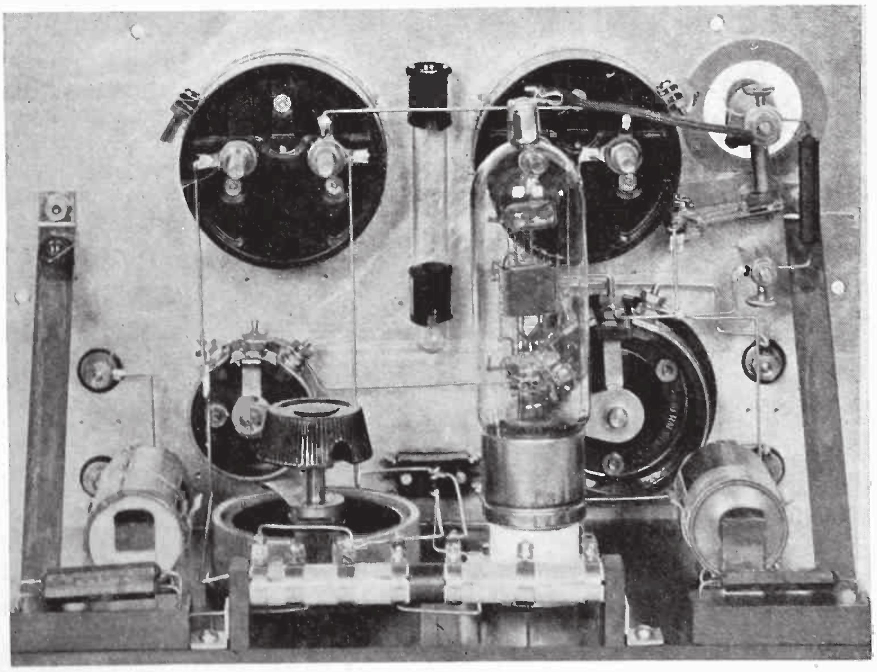
A BILLION-OHM BRIDGE



Rear view of an amplifier for measuring resistances up to a 1,000,000,000 ohms with only about one volt impressed

electronics

McGraw-Hill Publishing Company, Inc.
330 West 42d Street
New York City

O. H. CALDWELL, *Editor*

Volume VI —JUNE, 1933— Number 6

Radio cabinet styles and the Chicago exposition

IN cities and towns and villages all over the country, the family "bus" is being made ready for a summer excursion to the World's Fair at Chicago. Millions of people are going to inspect the wonder-palaces of science and electronics on the shores of the lake.

And when those families come back to their scattered homes, they will bring back with them new ideas of architectural design and artistic pattern. Other millions scan the photographs of the Chicago Exposition buildings in the rotogravures and magazines. The whole country is being made exposition-conscious.

The Chicago World's Fair may therefor be expected to have a tremendous influence on the tastes of people throughout America, even in the small towns and rural districts. The modernistic outlines of the Exposition will definitely affect the acceptibility of new designs for clocks, automobiles, furniture, plumbing, and above all radios. The new trends in radio design will find a waiting market which will be impatient with old-fashioned and Victorian effects of yesteryear.

Inventions by Government employees

GOVERNMENT employees may privately exploit for their personal profit the commercial results of patents gained by them unless specifically a part of their official duties undertaken directly under instructions of their superiors. This is the general effect of the decision April 10 in the Supreme Court of the United States telling the government that it may not claim ownership or title to the patents of two Bureau of Standards' investigators, F. W. Dunmore and P. D. Lowell.

The lower courts in this case had decided that this work of the Bureau of Standards had been undertaken by the inventors voluntarily, outside their official assignments, but had been allowed to continue with the knowledge of superiors after the patent conception had occurred. There was no question raised as to the fact that the work was done in official time using government facilities. But, the court says, this does not give the government more than a shop right to use an invention in its own interest.

The court finds that no right of administrative authority exists to deprive the individual employee of the rewards of commercial exploitation of his invention. It declares that the Congress has been silent on this point and that until Congress acts, employees may not be so deprived.

The automobile-radio installation problem

AUTOMOBILE radio continues to be the most active field on which the interest of manufacturers is concentrated. Automobile radio is going ahead this season beyond even the fondest dreams of its enthusiasts.

But now that a good business is underway, pains must be taken not to shatter the auto-radio price level in the way that home radios have been "all shot."

Manufacturers cannot expect dealers to get their installation expense out of the ordinary merchandising discount. The job of installation in the case of auto-radios is too complicated, too variable, to expect the retail contact with the public to absorb it in any ordinary list price.

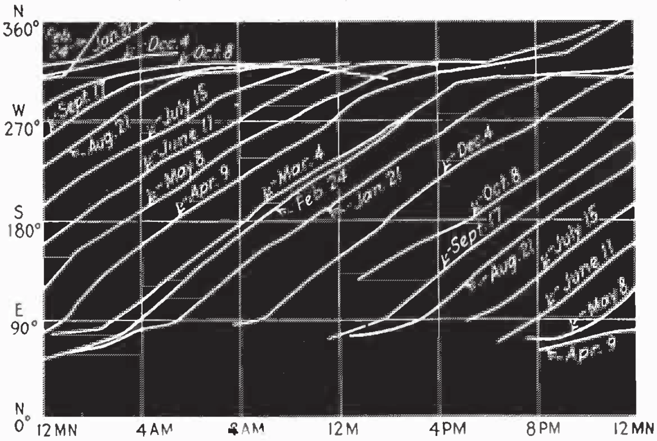
Some of the larger installers think that $5 apiece will cover the average run of installation jobs coming in to-day. But the little retailer, on whom a large aggregate volume depends, cannot operate at any such level. Into 80 per cent of the cars, antennas must be inserted, and then there are the problems of spark-suppression, mechanical movements in the pick-up field causing clicks, brake-static, and other insidious difficulties.

Automobile radio installation is still a radio man's job, and there seems no present way except to make each installation an individual case.

Hearing radio from the stars

DISCOVERY by Karl G. Jansky, of the Bell Telephone Laboratories, Holmdel, N. J., of a "radio hiss" from the depths of the universe, provides one more tie-up between the electromagnetic spectrum and astronomy. There can be no doubt of the sidereal origin of Mr. Jansky's static. For more than a year he has observed the changing of its position as it swings around the horizon daily, yet each day advancing four minutes, which corresponds to the changing position of the starry firmament, as the sun appears to move in front of the stars. More interesting yet, Mr. Jansky locates his static hiss as coming from a definite point in the heavens lying on the 18-hour Right Ascension meridian, which already is notable for two cosmic distinctions,—(1) the destination toward which the sun and solar system are speeding at 720 miles per minute, and (2) the gravitational center of our own Milky Way Galaxy of a hundred billion suns.

PROOF OF SIDERIAL ORIGIN OF RADIO HISS



A year's careful observations by Karl G. Jansky at Holmdel, N. J., have revealed the progressive sidereal shift of the radio hiss on 14.6 meters, following a definite point in the sky of stars

Of course, there is no definite evidence as to how far off is the interstellar broadcasting station whose output we are receiving. Certainly it must be prodigious, to lay down even such signal strength as pours in on our earthly receivers. But with billions of stars radiating energy at average rates of a sextillion kilowatts apiece, on other electromagnetic wavelengths, (light, infra red, ultraviolet), there would seem to be power aplenty for the observed radio phenomena.

▼ ▼ ▼

TECHNICAL PROGRAM, I. R. E. CONVENTION

June 26-28, 1933—Hotel Stevens, Chicago

Monday, 10 a.m.—Some Aspects of Radio Law, by J. Warren Wright, Navy Department; Patent Relations of the Engineer to His Employer, by Leonard Garver, Jr., Larbach & Garver; The Radio Patrol System of the City of New York, by F. W. Cunningham, Bell Telephone Laboratories and T. W. Rochester, New York Police Department; The Iconoscope—A New Version of the Electric Eye, by V. K. Zworykin, RCA Victor Company.

Monday, 2 p.m.—Vacuum Tubes for Use at Extremely High Frequencies, by B. J. Thompson and G. M. Rose, Jr., RCA Radiotron Company, Inc.; Vacuum Tube Characteristics in the Positive Grid Region by an Oscillographic Method, by H. N. Kozanowski and I. E. Mouromtseff, Westinghouse Electric & Manufacturing Company; Application of Graphite as an Anode Material to High Vacuum Transmitting Tubes, by E. E. Spitzer, General Electric Company; Determination of Dielectric Properties at Very High Frequencies, by J. G. Chaffee, Bell Telephone Laboratories.

Tuesday, 10 a.m.—Symposium on Cost vs. Quality in Broadcast Receiver Design: Tubes, by W. M. Perkins, National Union Radio Corporation; Coils, by F. M. Jacob, Meissner Manufacturing Company; Speakers, by H. S. Knowles, Jensen Radio Manufacturing Company; Condensers, by R. O. Lewis, P. R. Mallory Company; Resistors, by D. S. W. Kelly, Allen-Bradley Company; Transformers, by W. J. Leidy, Chicago Transformer Corporation; Circuits, by H. D. Mysing, Grigsby-Grunow Company.

Tuesday, 1:30 p.m.—Studies of the Ionosphere and their Application to Radio Transmission, by S. S. Kirby, L. V. Berkner and D. M. Stuart, Bureau of Standards; Electrical Disturbances of Extraterrestrial Origin, by K. G. Jansky, Bell Telephone Laboratories; Attenuation of Overland Radio Transmission in the Frequency Range 1.5 to 3.5 Megacycles, by C. N. Anderson, American Tel. & Tel. Company; Note on a Multi-Frequency Automatic Recorder of Kennelly-Heaviside Layer Height, by T. R. Gilliland, Bureau of Standards; Determination of the Direction of Arrival of Short Radio Waves, by H. T. Friis, C. B. Feldman and W. M. Sharpless, Bell Telephone Laboratories; Informal Technical Conference on "Criteria for the Introduction of New Tubes" led by J. C. Warner, RCA Radiotron Company.

Wednesday, 9:30 a.m.—A Study of Reflex Circuits and Associated Tube Properties in Modern Receivers, by David Grimes and W. S. Barden, RCA License Laboratory; A New Cone Loudspeaker for High Fidelity Sound Reproduction, by H. F. Olsen, RCA Victor Company; A Life Test Power Supply Utilizing Thyratron Rectifiers, by H. W. Lord, General Electric Company; Radio Cabinet Design and Consumer Acceptance, by H. L. Van Doren, Van Doren & Rideout.

+ NEW PRODUCTS

THE MANUFACTURERS OFFER

Glove-fitting tube shield

Having specialized in the design and production of parts for radio tubes, Goat Radio Tube Parts, Inc., 314 Dear St., Brooklyn, are now marketing a new design of tube shield. This differs from the conventional cylindrical type of shield in that it conforms to the shape of the dome type of bulb, which is why it has been christened the "glove-fitting" tube shield.

The shield is made in two halves, and these so formed that a clamping ring may be slid up on it from the lower end and snapped into the groove provided therefore, thus holding the two halves together, snugly hugging the bulb.

This tube shield is declared to cost less than the cylindrical type, partly in itself, and partly because it is so easily grounded by means of a simple clip fastened to the chassis. Furthermore, it is suggested that, in these days of smaller sets, the space saved as compared with the straight cylindrical type of shield might under certain circumstances be utilized for other parts of the apparatus and permit a reduction in the overall dimensions of the set.—*Electronics, June, 1933.*

Condenser microphone kit

Bruno Laboratories, New York City, has developed a kit of parts of a condenser microphone which can be assembled into a professional instrument. The parts are made with micrometer accuracy. A microphone of this type can be used for broadcasting, public address, or any purpose where good reproduction is required. Being a condenser microphone, there is no hiss or other extraneous noise. Overtones and coloring are well reproduced and the spoken voice is life-like, declares an announcement. The parts can be assembled into a microphone with only the use of a screw-driver. The kit is packed complete with instructions and also the hook-up for an efficient two-stage amplifier. Price, $5.—*Electronics, June, 1933.*

Test oscillator

A test oscillator having the frequency stability of a signal generator, has just been announced by the Clough-Brengle Company of 1134 West Austin Ave., Chicago, Ill.

This Model OA employs three tubes, the r.f. oscillator stage, a separate modulator stage, and a rectifier tube, for this instrument operates from any light socket, a.c. or d.c., eliminating battery cost and weight.

The "Electron-coupled" oscillator circuit gives freedom from frequency variation due to voltage change or input circuit conditions. Complete coverage of all intermediate, broadcast and short wave bands is provided, including the new 456 and 477.5 kc. intermediate frequencies used in the latest Majestic, Stewart-Warner, Atwater-Kent and other sets.

Output frequencies are adjusted to zero-beat against a crystal oscillator, and are sealed while the zero-beat is maintained. Price $29.70.—*Electronics, June, 1933.*

Dry electrolytic condensers

The Aerovox Corporation, 70 Washington St., Brooklyn, N. Y., has announced a new series of Aerovox Hi-Farad electrolytic condensers especially designed to meet the requirements for compact units for use in modern midget radio receivers and other small apparatus assemblies.

These condensers possess exactly the same general characteristics as other types of Aerovox electrolytic condensers in larger size cans, and are made in a wide variety of capacities and voltage ratings for use in all standard filters and bypass circuits.

Single section units in 1 in. diameter cans include types EM, GM, MM and SM; the two latter being especially suitable for bypass condensers.

Types GG and EE condensers present a radical departure from previous types of electrolytic condensers in $1\frac{3}{8}$ in. diameter cans, in that they are made with two or three terminals in the cover, permitting various combinations of capacities and voltage ratings in this size can. Type EE condensers are made for universal mounting with a mounting ring, and type GG condensers for inverted (grounded) mounting. —*Electronics, June, 1933.*

Peak voltmeter

The Sensitive Research Instrument Corporation of 4545 Bronx Boulevard, New York City, announces a new three-range peak voltmeter, reading 0-1-10-100 volts, the lowest reading obtainable being 0.2 volt. It is a direct reading instrument eliminating any calculations whatever and is independent of frequency. It is so designed that it has an infinite input impedance and is not dependent on a sine wave for its peak measurements. It is recommended for all peak voltage measurements, including peak of vibrator B-eliminators, mercury-vapor tube rectifiers, and portions of such circuits as well as thyratron oscillator wave-form peak voltages, irrespective of distortion. It is also obtainable in higher volt combinations. It can also be used to measure small-time transients regardless of frequency or combinations of frequencies, including peak values of pulsating direct-current voltages or currents. It is impossible to overload the instrument sufficiently to cause damage.—*Electronics, June, 1933.*

Flexible shaft for remote control

A new flexible shaft specifically designed to meet the requirements of remote control of radio receivers has just been introduced by the S. S. White Dental Manufacturing Company, Industrial Division, 152 W. 42d St., New York City.

The feature of this shaft which makes it particularly suitable for radio remote control is its reduced torsional deflection when the shaft is turned in either direction.

The ordinary type of flexible shaft designed for speedometer drives has a torsional deflection when turned in the winding direction of from 0.88 to 0.118 degrees per ounce inch per foot, and in the unwinding direction from 2.14 to 2.95 degrees per ounce inch per foot. The total deflection, in going from the winding to the unwinding direction would be 3.02 to 4.13 degrees per ounce inch per foot.

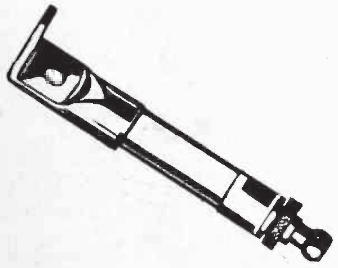
Compared with these figures the new No. 150L53 shaft has only 0.35 degrees per ounce inch per foot in either direction of rotation, or a total of 0.70 degrees per ounce inch per foot.

For use with this shaft a special small diameter metallic casing has also been developed in standard Parkerized finish. —*Electronics, June, 1933.*

›››› with Centralab

CRL

MOTOR RADIO SUPPRESSORS



The unique one piece construction "Baptized with Fire" in the making, guarantees absolute permanence regardless of operating temperature or humidity.

An automobile distributor reports 11.8 miles per gallon with his car equipped with ordinary suppressors. After substituting CENTRALAB, the mileage was 15.8 per gallon—an increase of 34 per cent.

Many motors show decreased mileage and power when spark suppressors are used. This results from the high D.C. resistance needed to suppress radio interference. Centralab's greater effectiveness at radio frequencies permits much lower D.C. resistance, insuring full motor efficiency on all cars.

CENTRAL RADIO LABORATORIES
MILWAUKEE WISCONSIN

Molded-carbon volume control

The Stackpole Carbon Company, St. Marys, Pa., announces its Type 100 molded-carbon variable resistor, a major advance in the design of volume controls and tone controls in radio receivers and manual gain controls in audio amplifiers. It consists of four major parts: 1, the insulated shaft molded permanently into the bakelite hub which carries the spring contact arm; 2, the bakelite frame or base upon which the unit is assembled; 3, the newly developed resistance element and 4, the shield cover with its associated power switch.

The resistance element is made in the form of a molded carbon ring of the same material employed in Stackpole fixed carbon resistors. After the manufacturing process, which makes possible any total resistance from a few hundred ohms up to a couple of megohms, any resistance taper to suit the particular application of the control, and any desired "hop-off" at either or both ends, the resistance element is fired in a continuous furnace at high temperature. This firing process imparts a hard, glass-like surface to the resistance unit, impervious to temperature, moisture, current or hard usage and forming a perfect surface for the nickel-chrome sliding contact. Thus there is no rough, granular structure to the surface to create noises, nor electro-chemical disintegration to cause irregular control action.—*Electronics, June, 1933.*

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Hot-wire time delay

The TD-7 hot-wire time delay, designed for applications where a short time delay is desirable and where rapid but not immediate recycling is required, is announced by Struthers Dunn, Inc., Philadelphia, Pa. The unit consists of a hot wire member, a bow member and two adjustable, fixed contacts, all mounted on a base of insulating material. It is designed for delays from one to five seconds, and the time of cooling is proportional to the time of heating up.—*Electronics, June, 1933.*

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Insulating materials

Arrangements have been made whereby Isolantite Inc., 75 Varick St., New York City, may fabricate parts from Mycalex made by the General Electric Company and market such fabricated parts in the United States.

The technical excellence of Mycalex and the fine qualities of Isolantite, have won for these products a wide acceptance in the communications and electrical fields. The selection of one or the other for a given insulating project, has been dictated largely by engineering requirements. Consequently, Isolantite and Mycalex are not competitive from a commercial standpoint. Those who have considered fully the determining factors in the choice of insulators for communication service have found that Isolantite and Mycalex supplement each other, to very great advantage.

To those having suitable tooling equipment for working Mycalex, and whose experience with this type of material qualifies them to undertake local fabrication, Isolantite Inc., is prepared to furnish Mycalex in standard size bar and sheet stock.—*Electronics, June, 1933.*

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Stroboscope

The International type 180 stroboscope makes available to the world of industry a piece of apparatus which has long been sought by practically all manufacturing industries. No matter what type of machinery is to be examined, whether it be an automobile engine, gears, transmissions, valves, electric fans, motors, printing presses running at high speed, airplane propellers, sewing machines, or any other form of rotating or reciprocating machinery, the Type 180 Stroboscope will make the machine appear to run in slow motion while actually the device is running at full speed. This accomplishment permits the manufacturer and user of any of these machines to observe why certain parts break down, or make excessive noise. A further description is given in Bulletin No. 28, issued by the International Broadcasting Equipment Company, 4508 Ravenswood Ave., Chicago, Ill.—*Electronics, June, 1933.*

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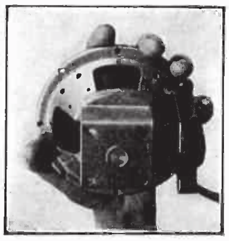
Dwarf dynamic speaker

Measuring only 5 in. in diameter the new Super-dwarf dynamic speaker made by Victory Speakers, Inc., 7131 East 13th St., Oakland, Calif., is built to meet the requirements of manufacturers of a.c.-d.c. receivers.



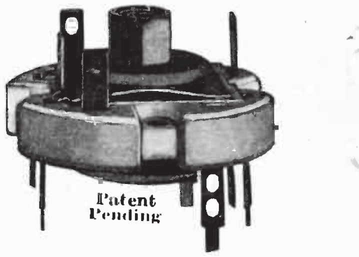
This new speaker is said to have splendid tone fidelity, surprising volume and audio response. Field excitation requirements are from 2 to 4 watts, with output transformer to match specified power tubes.

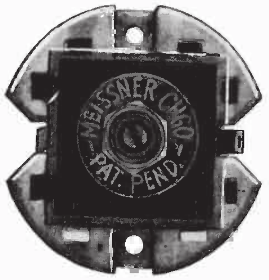
The company also manufactures a complete line of speakers, automobile-type speakers, and amplifiers.—*Electronics, June, 1933.*

Trimming condensers

The Meissner Manufacturing Company, 2815 West 19th St., Chicago, Ill., is now making a unique, very small, new double tuned trimming condenser particularly adapted to small intermediate-frequency units, although capacities up to 850 mmfd. are available.

The illustrations, actual size, show the two condensers, mounted on either side of the isolantite base. One side is tuned by a spintite, the other by a screw driver. Any combination of capacities can be had by varying the number of plates. The units are also available in the single tuned style. A folder describing the complete Meissner line of trimming and padding condensers may be had on request to the manufacturer.—*Electronics, June, 1933.*





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Manufacturers' bulletins and catalogs

Sound-studio equipment—The Wireless Shop (A. J. Edgcomb), 150 Glendale Boulevard, Los Angeles, Calif., has issued a new binder for its catalogs on speech-input equipment, transmitting condensers, fader controls, power-level indicators, rheostats, relay racks, and other apparatus for broadcast stations, sound-picture studios and laboratories.

Loudspeakers — Jensen electro-dynamic speakers are shown, with complete specifications, electrical resistances, size, prices, etc., in a circular issued by the Jensen Radio Manufacturing Company, 6601 Laramie St., Chicago, Ill.

Photoelectric meter — An illustrated description, with characteristics, of the A.P.C. photo-electric meter for measuring density of liquids, concentrations, turbidity, etc., is contained in Bulletin 103, Eimer & Amend, 18th St. and Third Ave., New York City.

Variable condensers—A new line of small variable condensers for modern compact radio receivers, is described with complete technical details and operating characteristics, in a bulletin issued by the DeJur-Amsco Corporation, 95 Morton St., New York City, manufacturer also of dials, varitors, rheostats, and potentiometers.

Colloidal graphite in resistors—The use of colloidal graphite in the manufacture of electrical resistances, particularly the application of Aquadag for this purpose, is described in a recent bulletin, No. 11.4, published by the Acheson Oildag Company, manufacturers of colloidal graphite products, Port Huron, Mich. Methods of producing resistors, tone-controls and grid-leaks are outlined.

electronics

radio, sound, communications and industrial applications of electron tubes • • • design, engineering, manufacture

The Industrial Recovery Act —and radio

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Resistance stabilized amplifiers

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What's next in radio cabinet styles?

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Electron tube oles in a esistor plant

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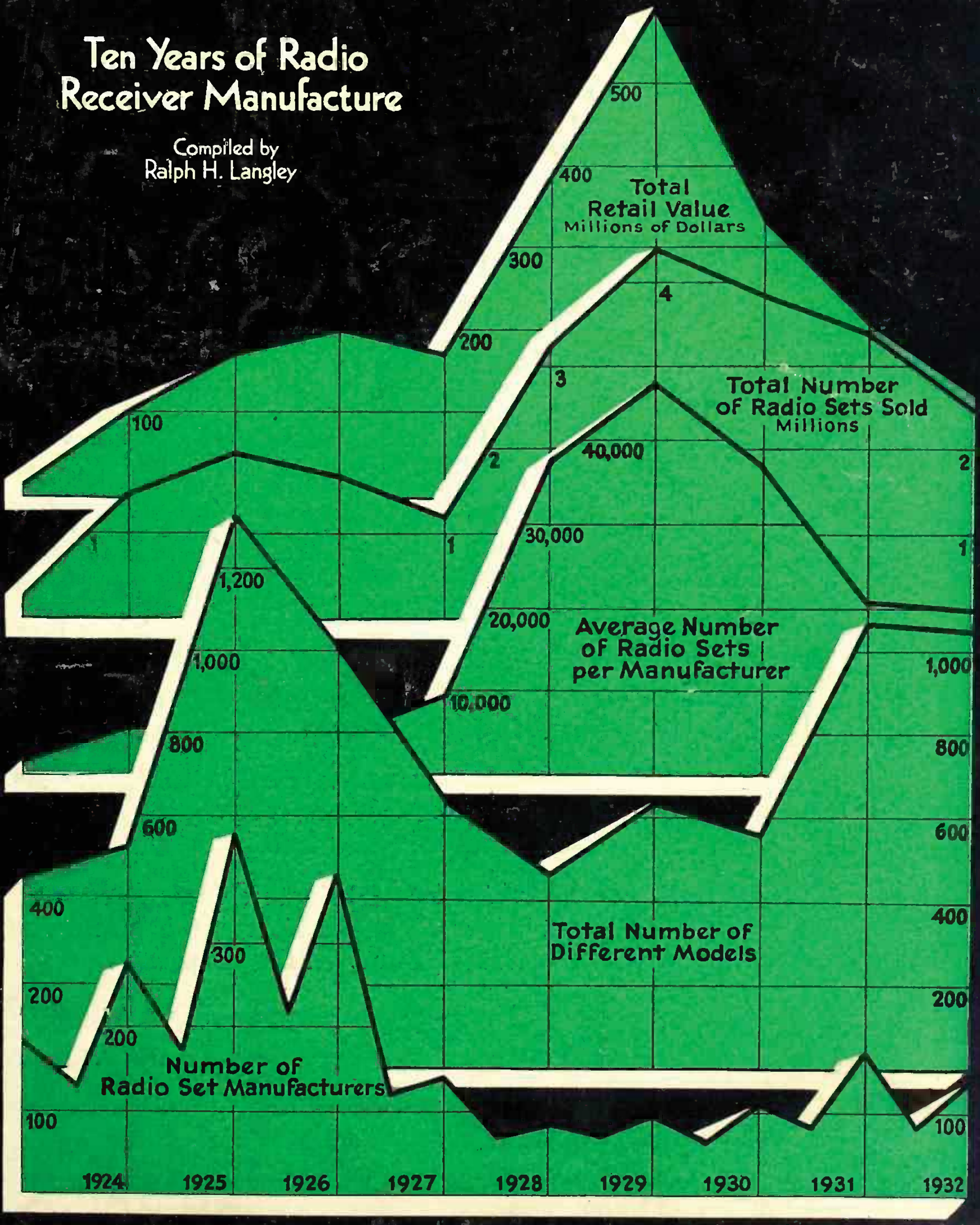
Sodium vapor ighting



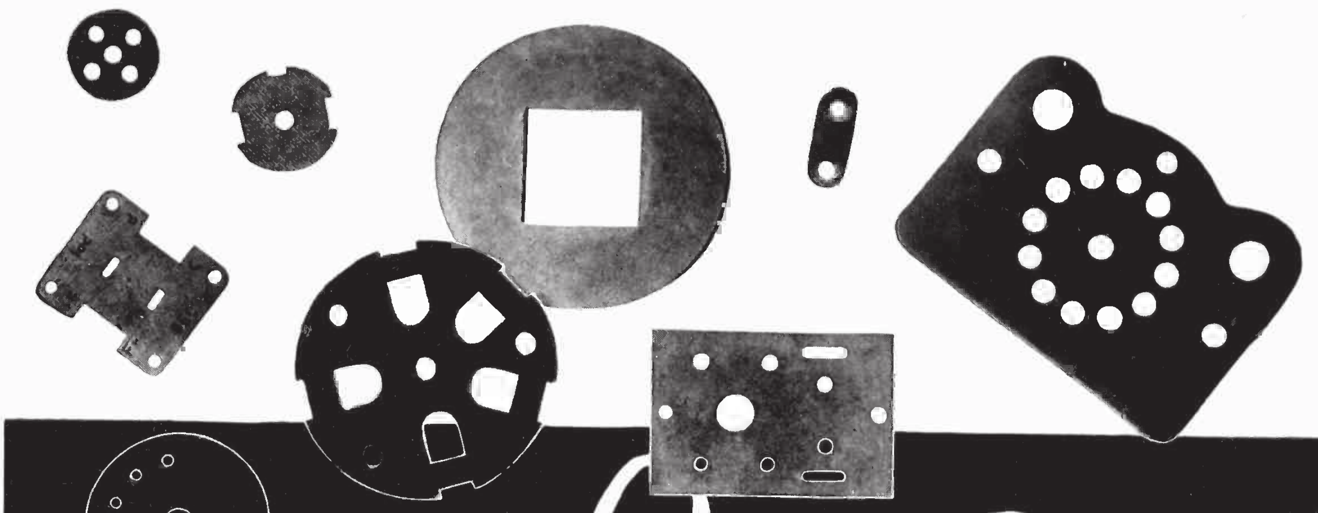
Ten Years of Radio Receiver Manufacture

Compiled by Ralph H. Langley

McGRAW-HILL PUBLISHING COMPANY, INC.

Price 35 Cents

JULY, 1933



Lower Prices increase FORMICA'S use as Insulation

FOUR years of depression have brought down the price of Formica a great deal, and made it available for a lot of uses that from the commercial standpoint might not have been practical at higher levels.

Formica is economical insulation. It avoids tear down and replacement that are far more costly than small amounts saved on purchases of insulating material.

Formica can fabricate and ship promptly such parts as you need; as it is available in sheets, tubes and rods from which you can fabricate your own requirements.

THE FORMICA INSULATION COMPANY
4626 Spring Grove Avenue, Cincinnati, Ohio

FORMICA

Electronics, July, 1933. Vol. 6. No. 7. Published monthly. McGraw-Hill Publishing Company, Inc., 330 West 42d Street, New York, N. Y. $3.00 per year, 35 cents a copy. Foreign postage, $4 U. S. Currency or 20 shillings. Canada (including Canadian duty), $3.50. Entered as second-class matter April 4, 1930, at the Post Office at New York, N. Y., under the Act of March 3, 1879.

O. H. CALDWELL
Editor
KEITH HENNEY
Associate Editor

electronics

McGRAW-HILL PUBLISHING COMPANY, INC.

Vol. 6, No. 7. New York, July, 1933

radio
sound pictures
telephony
broadcasting
telegraphy
counting
grading
carrier systems
beam transmission
photo cells
facsimile
electric recording
amplifiers
phonographs
measurements
receivers
therapeutics
traffic control
musical instruments
machine control
television
metering
analysis
aviation
metallurgy
beacons
compasses
automatic processing
crime detection
geophysics

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To Speed Sales in September

RADIO production and the jobs of radio engineers depend on radio *sales.*

Radio engineers and radio technical men generally will therefore be deeply interested in the plans which the Radio Manufacturers Association has underway for a vigorous Radio Prosperity Campaign during September.

This month of active retail selling,—coupled with rehabilitation of existing radio sets,—will prepare the nation for a great series of special broadcast programs—Radio Progress Week, October 2 to 7.

NEARLY seven million homes have obsolete radio sets which should be replaced. Thirteen million other homes have no radios at all. And among the millions of homes with workable sets, a large proportion need overhauling of installation, tubes or parts. Then there are the opportunities to sell second or third "additional" sets, and automobile radios. And to put radios in offices, shops, stores and places of business.

The Radio Prosperity Campaign is a constructive, well-planned effort to stimulate radio sales and radio prosperity all along the line—among set manufacturers, parts makers, raw material suppliers, and broadcasters. It is a united drive to get, for radio, the dollars of the general public, for which the manufacturers of automobiles, refrigerators, clothes, and other personal commodities will be bidding.

The Radio Prosperity Campaign will put radio "back on the map," this Fall .

Radio Prosperity Campaign, ... **September 1 to 30**
retail sales, and set rehabilitation
in preparation for
Radio Progress Week, ... **October 2 to 7**
outstanding broadcasts on the air

THE "INDUSTRY RECOVERY

Employment and wage-scale proposals placed ahead of price-fixing and allotments by General Johnson

INDUSTRY'S "New Deal" is under way.

With the signing of the National Industrial Recovery Act and the appointment of General Hugh S. Johnson, as its administrator, President Roosevelt has put into action a revolutionary change in the industrial structure of America.

And now, like other businesses and industries, the radio industry is trying to find out just how it fits into the new industrial picture under the National Recovery Act, and what its responsibilities and benefits will be under the new plan as administered by General Johnson and his deputies.

Many business leaders and radio men had assumed, from their first readings of the Act, while it was before Congress, that here was a piece of legislation that primarily offered a convenient basis for entering upon price agreements between business competitors and the raising of price levels to consumers.

Undoubtedly these results will be among the eventual consequences of the economic forces set into motion by the National Recovery Act. But advices from Washington representatives of *Electronics,* who have been in close touch with the Administrator's office, now make it very clear that not price-fixing but EMPLOYMENT is the subject around which the Recovery Act revolves.

Employment and wage-scales first

Putting men back into jobs, rising wage scales, and the *spread of existing employment,*—these are paramount factors in which the Administrator is interested. In fact, he is not disposed even to consider codes unless these provisions for employment are prominent and effective. Industry groups who travel down to Washington with elaborate codes and agreements on price-fixing, are likely to be waved aside and asked to present, instead, their plans for *putting men back to work!*

General Johnson, center, and his labor advisors. Seated, Secretary of Labor Perkins and Dr. Leo Wollman, labor economist. Standing, John Frey, American Federation of Labor, and Edward F. McGrady, labor assistant to General Johnson

This National Industry Recovery Act was passed to give employment to men now out of jobs, and for no other purpose, is the theme that will be heard time and again around the Administration's offices. Everything else is secondary. The test is—

"What does your industry need *in order to put men to work.* Tell us how many people you can put to work, what wages you will pay them, and how work can be spread in order to get as many as possible on the payroll —so that the country's buying power may be restored as rapidly as possible.

"Those are things the Industrial Recovery Administration wants of industry, even roughly outlined, but at the very first. Then later come back with your price plans and trade agreements and let us see what you think is necessary in the way of price determination to keep such an employment schedule going.

"And let's see that we have wage increases before we have price increases. Wage increases will stimulate the country's buying power and get things going of their own momentum. But premature price-increases may stifle the very prosperity we are seeking to kindle and fan into flame!"

Industry groups who have gone to Washington have been told clearly that General Johnson's office considers it inadvisable for business groups to attempt to fix prices or to allocate production at this time. Back of this position, it appears, is the fear that Senators and Congressmen will find the new Industry Act guilty of "gouging" the public or promoting monopoly or wiping out small manufacturers.

If an industry's Code should go too far on this matter of fixing prices and allocating production, such a rumpus might be kicked up in the public mind that when the next Congress meets, industry is likely to have new additional severe restrictions put on it that are likely to hold it back or pull it down.

Sale below cost, is unfair competition

Furthermore in the actual administration of the Act, as so far carried out, business men who have discussed the situation with the powers-that-be in the Commerce Building, are told without quibbling that while the Government naturally wants business men to make a profit on the business they do, yet the Government cannot agree to a price which has a profit in it,—that is, cannot be put in the position where it is even impliedly guaranteeing to a manufacturer, a profit.

On the other hand, General Johnson's office has stated to callers that the code of an industry, like radio, may provide that any sale which is made below the cost of production, shall be deemed unfair competition. Such a provision in industry codes would seem to go about 90 per cent of the way toward a reasonable price level, so undoubtedly industry codes will be shaped up based on

ACT"—AND RADIO

Administrator will not guarantee a profit, but declares sales below cost to be "unfair competition"

the cost of production. Incidentally, such a provision, it should be noted, involves the setting up of a uniform system of accounting for the industry asking to operate under such a cost-of-production Code.

But as already pointed out, labor and employment are the main points on which the Administrator will judge any Code submitted to him. How basic is this kind of thinking in the Administration offices, is revealed by the classification of industries, not in terms of what they produce, but in terms of the *kind of labor which they employ*. Thus shoes, belting, and leather goods would be grouped together; as would glassware, incandescent lamps, window glass, etc. So, also, jobbers employing warehousemen, packers and shippers would be classed together, regardless of what they dealt in.

And as emphasizing this labor aspect, now it even appears that President Roosevelt's famous dictum about "ten per cent of an industry" destroying the business soundness of the whole, referred not to gyps and price-chiselers as radio men supposed at the time, but was directed particularly at recent sweatshop *labor* practices, and was not intended to have the wide application with which business men clothed the remark.

Seven points for industry co-operation

But with careful planning of the codes for individual industries, and with the general improved conditions, there is no doubt that benefits will result to the radio industry and other business groups, growing out of the National Industry Recovery Act.

Here are some of the conditions which can underlie improvement in the radio and other industries:

1. Employment and purchasing power rising
2. Uniform hours and uniform wages as a foundation
3. Uniform cost accounting on production
4. Cost of production as the minimum selling price (affording a substantial brake on overproduction)
5. Publication by each manufacturer of his list prices and discounts
6. Secret rebates and unfair advertising made "unfair competition"
7. Retail price maintenance.

Millions of men at work by snowfall—that is the goal of the Administration. And not merely three million men, as had at first been supposed was the President's aim, but six to seven million more people in jobs and earning satisfactory livings under "the American standard," before the first chilly nights of winter roll 'round.

So important does President Roosevelt consider the administration of the National Industrial Recovery Act, that he is keeping in close touch with the progress of the Administrator's office personally, and it is understood that the first principal industry codes will not be approved without his personal study and sanction.

General Johnson is the Administrator who heads up the office.

As Deputy Administrators contacting the industry groups and holding hearings, there have so far been appointed W. L. Allen, former chairman Sheffield Steel Company; Earl D. Howard, former vice-president Hart, Schaffner & Marx; Arthur D. Whiteside, president of Dun & Bradstreet; Gen. C. C. Williams, former chief of ordnance U. S. A.; K. M. Simpson, president International Chromium Process Company; Nelson Slater, president S. Slater & Sons, cotton goods, and Malcolm Muir, president McGraw-Hill Publishing Company.

Members of the Industrial Advisory Board, charged with long-term planning, appointed by Secretary of Commerce Roper, are Austin Finch, president Thomasville (Ga.) Chair Company; Edward N. Hurley, chairman Hurley Machine Company, Chicago; Louis Kirstein, vice-president William Filene's Sons, Boston; Alfred P. Sloan, president General Motors Company; Walter C. Teagle, chairman Standard Oil Company, Gerard Swope, president Genreal Electric Company; William J. Vereen, Georgia cotton manufacturer.

The Labor Advisory Board, named by Secretary Perkins, is headed by Dr. Leo Wolman. The Consumers Advisory Board, intended to represent the interests of the general public, is headed by Mrs. Mary Rumsey.

General Johnson will have as his administrative assistant for industry, Dudley Cates, of Chicago, and as his assistant for labor, Edward F. McGrady.

RMA committee drafting radio Code

The Radio Manufacturers Association has been active in seizing the opportunity to formulate a code for the radio industry. President Fred Williams has appointed a committee on Industrial Recovery to draw up the code, survey the industry, and contact Washington, with the assistance of Executive Vice-President Bond Geddes. This Industrial Recovery Committee of the R.M.A. comprises:

Chairman, W. Roy McCanne, president Stromberg-Carlson Telephone Manufacturing Company; members, Paul Klugh, Zenith, Chicago; S. W. Muldowny of National Union, New York; Leslie Muter, The Muter Company, Chicago, and Arthur Murray of United American Bosch, Springfield, Mass.

The R.M.A. Code, when drafted, will presumably first go to the board of directors and to the membership for approval, before being submitted to General Johnson's office. It is understood that the hope is to get the radio-industry Code into operation by the end of July, in order that the radio business may get the benefit of Code cooperation through the coming radio season. Incidentally that will provide a severe test of the unity of mind of the industry, if such speed is to be accomplished. But there seems no doubt that a Code can be developed that will bring beneficial results to radio and the radio industry.

Electronics in resistor manufacturing

By LEON PODOLSKY
Wirt Company
Philadelphia, Pa.

THE rapid growth of the radio industry set an all-time mark for the development of manufacturing enterprises. Many have been the companies which have sprung up and flourished as manufacturers of the component parts of these receivers.

When one realizes that eight or ten composition resistors are used in each receiver it can be seen that a resistor manufacturer with several large receiver customers must have a large production capacity and the ability to produce with speed, uniformity and accuracy of resistance value, by the hundred thousand resistances of the order of several megohms.

The task of gearing up plants to handle large volumes with accuracy naturally falls to the engineering department. New methods of control for the intricate and critical processes of resistor manufacturing must be devised. The remarkable results which have been produced have been due largely to electronic principles.

Each of the millions of resistors made must be tested for resistance tolerance. Manual and visual inspection methods are outmoded. Two electronic devices for the automatic testing of composition resistors are shown in Figs. 1 and 2. These methods employ a mechanical system of conveyors and ejectors to bring the resistors from a storage magazine to the testing station.

In Fig. 1 is a schematic diagram of a bridge circuit, two arms of which are vacuum tubes, the other two arms being a standard resistor and the unit to be tested, respectively. A standard resistance of the nominal value desired is placed in the plate circuit of tube A in the position marked "Standard," and another resistance of the same value in the "X" position in the plate circuit of tube B. The grid biases are then adjusted by means of the potentiometers R, so that the plate currents of the tubes are equal. Then the voltage difference between the plates of the tubes is zero and the galvanometer relay, G, is the neutral position. Now, if the standard placed in position X is removed and the resistors to be tested are brought successively to this position, the plate current of tube B will be dependent upon the resistance value of X, and consequently a voltage difference will appear across the plates of the tubes if X varies from the value of the standard, the magnitude of which will be dependent on the degree of this variation. The polarity of this voltage difference will be dependent upon whether X is higher or lower in value than the standard and consequently governs the direction in which the galvanometer relay closes. The contacts of the relay are connected to suitable circuits for operation of the mechanical ejecting mechanism which separates the resistances into three groups, inside limits, higher-than-limits and lower-than-limits. The amount by which X may vary from the standard without being ejected, is controlled by the shunt S across the relay, this shunt being adjusted to allow a proper current to close the relay. Several such circuits are usually mounted in conjunction with a single conveyor system. As many as twenty stations, each set to select a different resistance value have been employed. This method is independent of variations in tube characteristics since the grid biases can be adjusted to have the tubes draw the same plate current if it becomes necessary to change tubes or if recalibration is necessary.

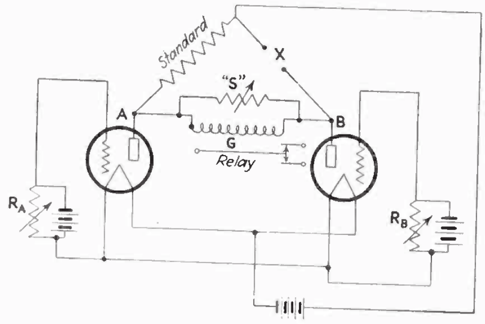


Fig. 1—Bridge for testing resistors

Another method for automatic testing of resistors is shown in Fig. 2. This shows a standard bridge circuit with the positions of the battery and galvanometer reversed from their usual positions, to allow higher voltages to be applied to the bridge to increase its sensitivity at high resistance values.

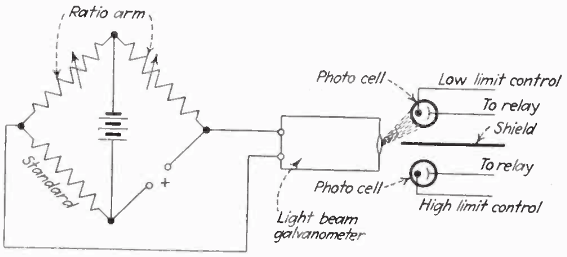


Fig. 2—Phototube automatic sorter

The indicating device used is the familiar light beam type of galvanometer of the Leeds & Northrup Company, developed especially for resistor measurements. The deflection of the light beam is, of course, dependent on the degree of variation of X from the standard resistance of the bridge. Consequently the two photocells are spaced a distance apart which corresponds to the deflection of the light beam galvanometer at the high and low resistance limits. The conveyor brings the units to be tested successively from a hopper to the testing station where contact is made to them. If the resistance value of the unit being tested differs from the standard, the bridge will be unbalanced and the light galvanometer will deflect right or left, according to whether the X unit is higher or lower than the standard. If this deflection corresponds to the limit of variation of resistance, or is greater than this limit, the light beam will sweep across one of the photocells and operate the associated relay and ejection mechanism and the resistor is eliminated.

Volume control inspection

Testing variable resistances, such as volume controls and tone controls, has always presented a problem since they are usually tapered in resistance value corresponding to certain degrees of angular rotation. The diagram shown in Fig. 3A is the circuit diagram of a cathode-ray tube device to test the resistance taper of variable resistances. A jig, in which the control to be tested is placed, is arranged so that a standard variable resistance of the correct taper can be rotated at the same time as the unit to be tested. The cathode-ray tube has two sets of deflection plates and the circuit is so arranged that the voltage picked off the control under test is applied across the other set of plates. Thus, the electron beam of the tube can be made to move in any desired direction proportional to the resistance values of the standard control and the control under test. The desired resistance curve can be drawn on the face of the tube, together with the limits of resistance variation. The operator in production has only to place controls to be tested in a test jig associated with the properly calibrated and marked cathode-ray tube and to follow the spot on the tube as the control is rotated. If the spot remains between the limit curves throughout the rotation of the control, the control is satisfactory. If the spot moves outside the limit curves it is rejected. Thus a continuous check on the resistance taper of any control can be had rather than the usual tolerance check at only two or three points.

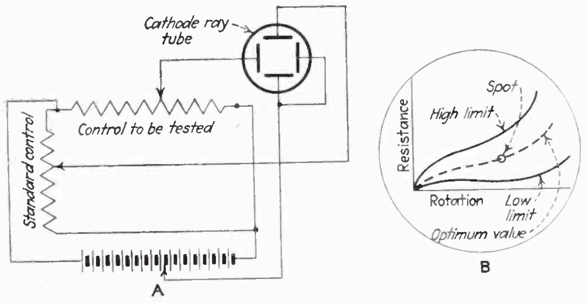


Fig. 3—Volume control inspection method

The use of medium temperature furnaces in resistance manufacturing is quite common and the requirements as to the allowable temperature variation are usually quite severe. A system used to control the temperature of a furnace, which employs a thyratron tube is shown in Fig. 4. A special resistance thermometer, R_2, placed in the furnace is made the 4th and variable arm of an a.c. Wheatstone Bridge. The temperature is adjusted to any desired value by variation of the resistance of one of the fixed arms of the bridge. At normal temperature no voltage is present across the input to the insulating transformer in the indicator position of the bridge. An increase in temperature of the furnace from the normal value changes the resistance of the thermometer arm and unbalances the bridge. A voltage is consequently applied to the transformer and then applied to the grid of the thyratron so that the grid is made negative during the half cycle when the anode of the tube is positive. This application of negative voltage to the thyratron grid stops the flow of current through the tube and allows the relay to open and interrupt the heater current. Likewise when the temperature of the furnace falls below its normal value the opposite phase is unbalanced and the thyratron closes the relay. One furnace using this type of control maintained easily a temperature of 500° C. within 5°.

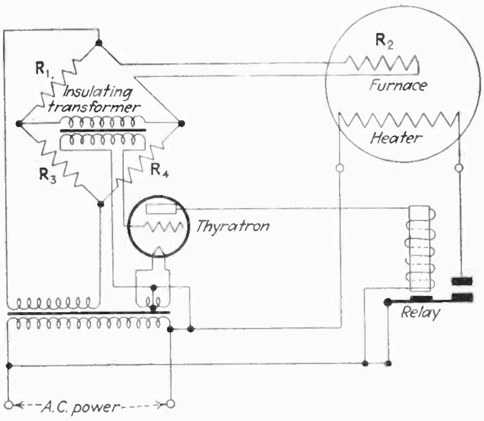


Fig. 4—Temperature control by electron tube

Many heavy viscous liquids are used in resistor manufacturing and it is important that the viscosity of these be the same every time they are used to maintain the uniformity of the finished product. A simple method of checking the viscosity of such heavy fluids is shown in Fig. 5. A quantity of the liquid to be tested is placed in the inclined glass tube which is inserted between two spaced coils in the grid circuit of a vacuum tube. A heavy steel ball is then rolled through the liquid in the glass tube and when this ball passes through the two coils two successive clicks are heard in the headphones or two flickers of the plate millimeter are seen. The time required for the ball to roll the distance D through the liquid in the tube at a given angle and at a certain temperature is a measure of the viscosity of the liquid. For direct comparison of different samples of the same liquid it is only necessary to note with a stop watch the time between the two flickers of the plate meter, or the two clicks in the phones, for a standard liquid of the proper viscosity, at a given temperature, and to compare this time with that obtained for other samples, a longer time indicating high viscosity and vice versa.

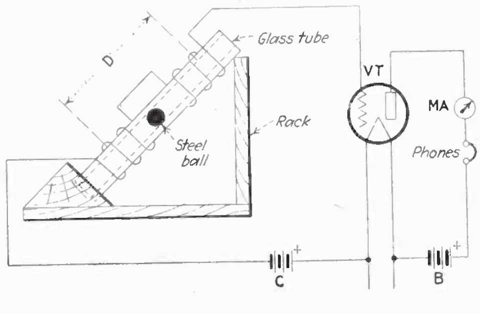


Fig. 5—Viscosity test device

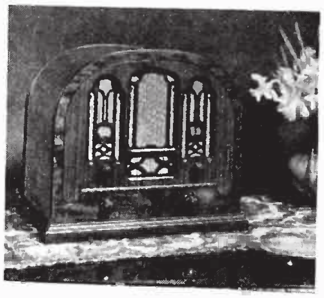
Radio cabinet design

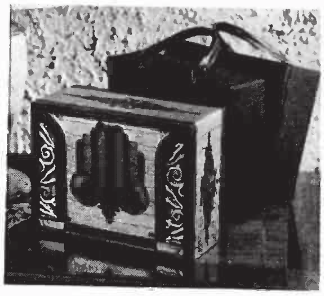
Where do we go from here?

By RUTH KOCH GERTH*

Designer, New York City

THE CABINET-DESIGNER'S


ATWATER KENT


BALKEIT

IT is quite possible that the next couple of years will be an important period in the history of radio design. We shall witness the casting aside of old ideas and the introduction and promotion of new types of radios. The new era will give us radios original and legitimate in conception. We shall go further in the present direction of new materials, new forms, new colors, new finishes.

We laymen had our first unalloyed pleasure in radios when the results of the mechanism were our main desire, when radios were merely boards which held innumerable and intricate technical contraptions which, if manipulated carefully, brought forth music. We were tremendously pleased with the wonder of it. But the ardor of our first thrill was soon dampened (soaked would be a better word) by the lack of good taste and the atrocious design of the coverings or cabinets which were made to protect the contraptions.

When the engineering problems were solved and the mechanical features of radio became more or less standardized, attention was directed to the design of a case to house this mechanism. With this step radio lost its identity. All the dignity, the romantic and intriguing qualities of radio receiving were ignored.

A radio became a box, a camouflage, a disguise. It was secreted between false book covers, concealed in lamp bases, and masked by clocks. Knobs and dials were made in queer shapes with uneven markings and placed so inconspicuously that it became a problem to tune in a station.

Radio a byword for bad taste

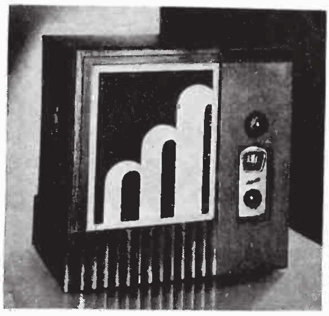
Sets were sold, but the buyers were not pleased. The more discriminating of them removed the "works" from their boxes, rather than inject the bad taste of the cabinets into their homes. Others allowed the sets to take up space in their living rooms but apologized for them when guests arrived. The sets were so bad in design that radio became the byword for bad taste.

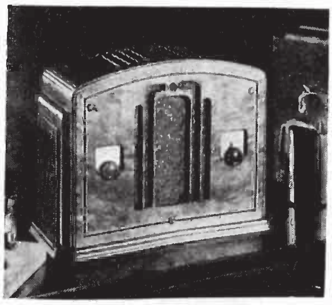
But all signs now point to a new era in radio design. The near future should witness a revival of our first pleasure, and should stimulate a new interest in radio, for manufacturers seem determined to see that radios shall receive their rightful position in the scheme of modern living.

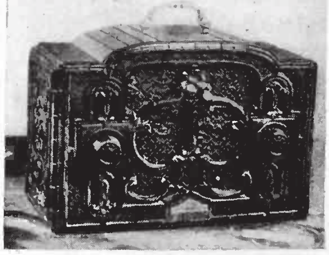
If the buyers' instincts and wishes are taken into consideration the new sets will be, and will appear to be, fine musical instruments. They will look like radios and not like writing desks or treasure chests. Dials and knobs will be important details of design. Dials will be easily read (no tricky square ones), and knobs will be large enough to handle comfortably. These features which function and are peculiar to radios should receive special attention. Clever designing of them would not only be honest and legitimate, but would add "swank" and smartness to the set, just as smartness is added to automobile body design by the accentuation of the design of radiator and fenders.

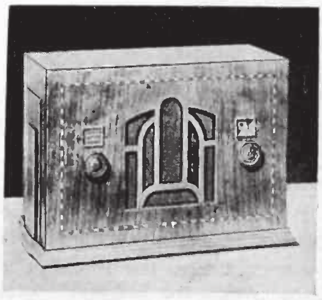
The new instruments should be far removed from the present box-like appearance of radios. Music spells

SOME OF THE RADICAL NEW DESIGNS IN RADIO CABINETS—

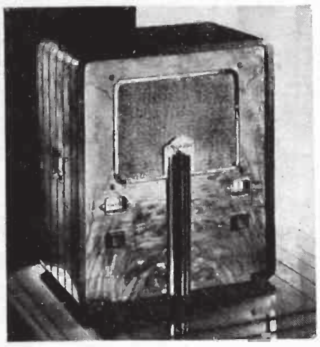

MAJESTIC


PHILCO


GENERAL ELECTRIC


AMERICAN BOSCH

JOB IS TO GIVE NEW SALES APPEAL TO RADIO SETS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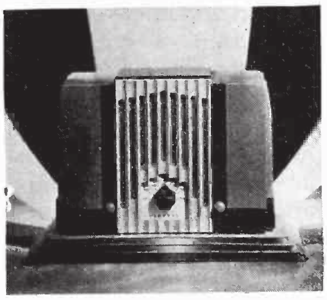
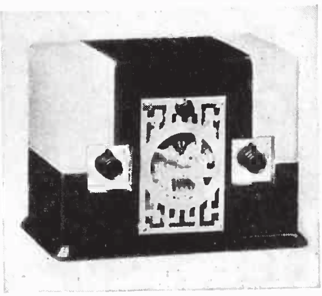
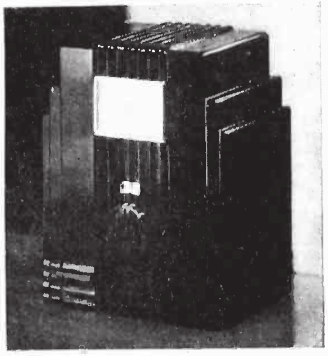

INTERNATIONAL


CLUB RADIO


AIR KING

something else to the average person. Music from the box-like upright piano never sounds as sweet as from a grand piano,—for the eye is not satisfied. The graceful curves of the grand piano follow the varying lengths of the strings and one sees the rhythm of music and feels it physically before a note is heard. Contrast this with the feeling derived from the boxed upright piano or the cramped midget set. In the midget set, not only is the shape lacking in grace and rhythm, but the relation of proportions is all wrong—there is too great a contrast between seeing and hearing. A concert received through a midget makes the set seem very unsatisfactory, picayune, and dinky in character.

Now that the introduction of the cheap, small set has made it possible for everyone to possess a radio, the mere desire for possession will not be sufficient to induce a purchase. Radio buyers will be interested in better quality in reception and design. Undoubtedly, this will lead to the introduction of two-unit receivers. The loudspeakers will be designed with accompanying adequate baffle-board area, and the tuning apparatus will be a smaller affair capable of being used in most any convenient spot. The most logical spot in the average living room is the space now occupied by the midget on the book-case shelf. If these remote control mechanisms become popular there should be one design, at least, which would fit a shelf. It should fit, not only in dimensions, but in character, so that it would not seem out of place in association with fine books. This does not mean that it should be camouflaged to look like books, but it might be leather covered and ornamented with tooling in keeping with book bindings.

Now that electronics has made possible finer music from records, the phonograph has become popular again. Aside from remote control possibilities here, as in radio, added impetus will be given to the use of the combination radio and phonograph outfits. Of necessity, such combination instruments will be large and hence the appearance will be of prime importance.

Women will control purchases

Women will have a great deal to say about the selection of these radio sets and combination units for the home, and women are interested not only in the performance but also in the design of the apparatus which makes the performance possible. They want to be as pleased when they look at the set, as when they listen to it.

Wise manufacturers will keep an eye on the magazines which women read, and they will study the design of contemporary furnishings in order that they may make their product in character with these furnishings. Timeliness in design must also be considered. Such women's magazines promote the present mode of living and all things particularly applicable to this mode, and thus the woman reader becomes conscious of a definite contemporary feeling exemplified in all products worthy of mention. And she looks for it when purchasing any new article.

Manufacturers would do well to cater to the lady of the house. She considers radio a fine, important, necessary adjunct to modern life. But she insists that it be sane and honest in design and an expression of charm and good taste.

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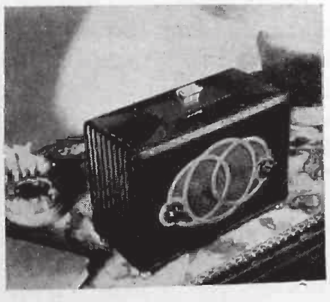
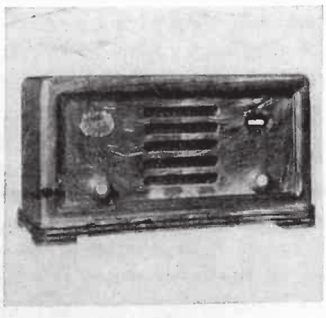
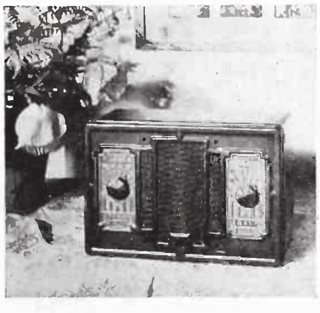
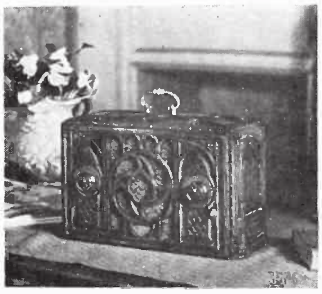
*Ruth Koch Gerth is a well-known free-lance designer of New York City. She is vice-president of the Artists Guild, Inc., a member of the American Union of Decorative Artists (Audak), and a member of the National Alliance of Art and Industry. She works with her husband under the partnership of Gerth & Gerth, 307 East 44th Street, New York.

EMPLOYING NEW MATERIALS, NEW FORMS AND NEW COLORS


COLONIAL


ZENITH

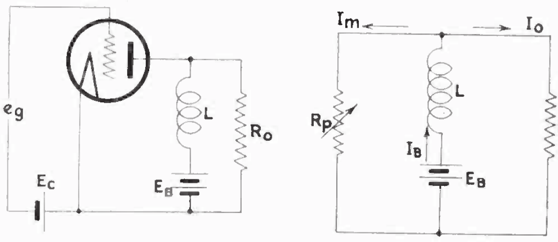

CROSLEY


RCA-VICTOR

A simplified method of modulator design

By E. A. LAPORT

In everyday engineering practice one must frequently seek new methods of calculating designs that are less tedious than the conventional processes. This paper outlines a short-cut method for designing a modulator for a stated performance. Aside from its time saving merits, it provides a good physical picture of the mechanism of operation.



Typical modulator and equivalent circuits

The procedure is to obtain the characteristics of the load which is to be modulated; to compute the current and voltage conditions existing in the load when it is modulated in the desired degree; to compute the current in the modulation reactor circuit to give the modulating voltage; to determine the modulator characteristics to give these conditions; and to apply these computations to the static characteristics of the type of tube to be used to obtain the dynamics characteristics, the excitation required and associated information.

Modulation is usually applied to an r-f oscillator or amplifier. The oscillator or amplifier constitutes the load, and appears to the modulating circuits like a pure resistance of value

$$R_o = \frac{\text{Plate volts}}{\text{Plate current}} = \frac{E_b}{I_o}$$

It is desired to modulate the power delivered to this resistance by a given amount. By definition, the modulation factor is the ratio of the peak value of a-c applied (superimposed upon the plate voltage) to the value of the plate voltage E_b.

$$K = \frac{{}^mE_p}{E_b}$$

For a given factor of modulation, therefore, the plate voltage E_b has superimposed upon it an alternating component of voltage of peak value

$${}^mE_p = KE_b$$

Since the instantaneous values of both components are applied simultaneously across the resistance R_o, the instantaneous currents are in phase with the voltages, and of course the power dissipated in the load will vary as the square of the voltage.

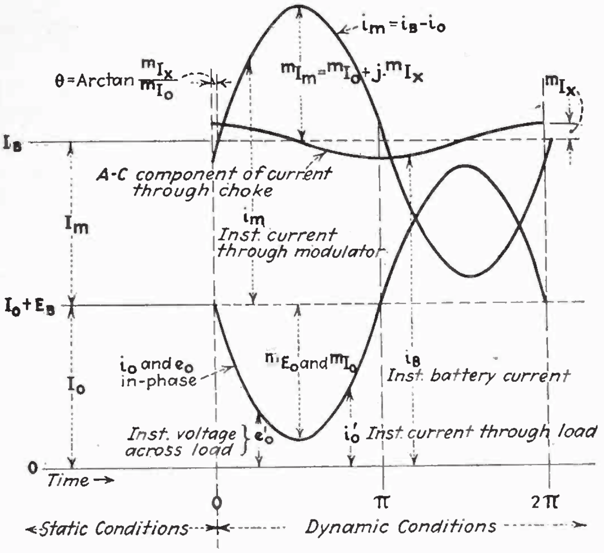
The work of the modulator is to produce this alternating voltage component known as the modulating voltage. To do this by the commonly used Heising system, the modulator circuits are connected in parallel with the load so that the modulator plate current is supplied by the same plate voltage supply as the load, through an inductance connected in series with the plate supply. The action of the modulator is to give rise to an alternating component of current through the inductance that will generate the required modulating voltage.

The current through the inductance must therefore have a peak value equal to the peak value of the modulating voltage divided by the reactance of the inductance at the lowest frequency to be reproduced. Ordinarily the reactance of the coil is much greater than the resistance of the load. The reason for this is apparent during the process of designing the modulator, for it becomes evident that the smaller the amplitude of the current through the inductance, to generate the desired modulating voltage, the more nearly the modulator plate current will approach the ideal 180° phase relation with the load current, and the more nearly does the modulator dynamic characteristic approach a single line.

Since the current through the inductance lags the voltage across it by 90°, and since the load current is in phase with this voltage, the load current must lead the current through the coil by the same interval. These currents can be plotted out in rectangular coordinates to scale.

The total current delivered by the generator is equal to the load current I_o plus the modulator current I_m when there is no modulation. The total current delivered by the plate generator E_b is equal to the sum of load and modulator currents at any instant, but during modulating the total plate current is equal to the steady load current, plus the steady modulator current, plus the alternating component (of average value zero) which builds up the modulating voltage. This latter component is the only change in total plate current that takes place when modulation is introduced into the system, assuming that the modulators give symmetrical output waveform. If the component is of negligibly small amplitude compared with the load a.c., the modulator plate current will be essentially equal and opposite to the a.c. of the load. But due to the fact that the modulator plate current cannot go to zero without encroaching on the lower bends of the static characteristics, with consequent distortion, the average modulator plate current must be somewhat more than equal to the peak value of the a.c. of the load. For an initial calculation add 10 per cent, and correct later when working out the dynamic characteristic of the modulator.

We now know the total plate current for the load and the modulator with the a-c component in its proper phase relation instant for instant, and we know the instantaneous current through the load and its phase relation. At any instant therefore, the modulator current will equal the total minus the load current, which is a matter of arithmetical subtraction instant for instant. Plot the modulator current curve out with the others and the

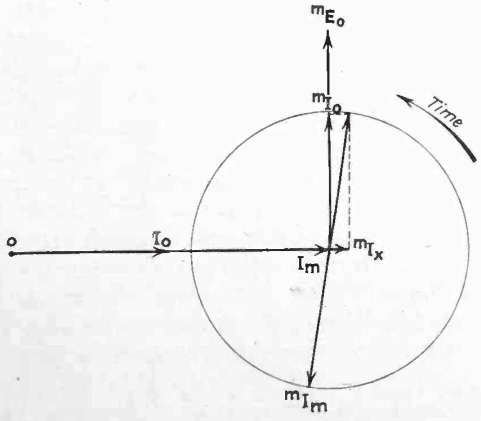

$i_m = i_B - i_o$
θ=Arctan $\frac{^mI_x}{^mI_o}$
$^mI_m = {^mI_o} + j\cdot{^mI_x}$
^mI_x
I_B
A-C component of current through choke
I_m
i_m
Inst. current through modulator
$I_o + E_B$
i_o and e_o in-phase
^mE_o and ^mI_o
i_B
Inst. battery current
I_o
Inst. voltage across load
e'_o
i'_o Inst. current through load
0
Time →
0
π
2π
Static Conditions
Dynamic Conditions

Current, voltage, and phase relations in a modulator tube

whole picture of the dynamic conditions are revealed.

Note that the modulator conditions thus obtained are for the entire modulator, which may require more than one tube. Select the type of modulator tube whose rating most nearly suits the operating voltages and currents. Divide the total power delivered to the modulator circuit by the plate dissipation capacity of the tube selected (or under consideration for selection) to obtain the number of modulator tubes required to give the desired performance. Then take a set of static characteristics for the type of tube selected and remark the current ordinates by multiplying each value shown for one tube by the number of tubes to be used. The static characteristics for one tube are now transformed into the static characteristic for the actual number of identical tubes to be used when they are connected in parallel. At the same time the curves for one tube are present by reference to only the original current ordinates.

Over the static characteristic curves for the complete modulator, locate the ordinate corresponding to the applied plate voltage, and run up this voltage ordinate to the point corresponding to the average modulator plate current as previously calculated. When there is no modulation, this will be the modulator plate current, and this point is called the operating point. This point will also fall on some value of grid voltage shown on the curves, which will become the bias voltage. Now to describe the dynamic characteristic, it is necessary to plot, point for point throughout a cycle, the instantaneous modulator plate current against instantaneous modulator plate voltage on the static characteristics. These values are already known from previous calculations. For a certain value of plate current occurring at the instant of a certain value of plate volts, a point is located on the tube curves. A succession of these points describes the dynamic characteristic curve, with corresponding grid voltages which is the required excitation to produce the conditions outlined.



Vector relations in modulator

Avoidance of distorting conditions

After the dynamic curve is obtained, refer to the single tube values to see what each tube must do. If there were points that could not be plotted on the curves because the points were non-existent, it means that the desired conditions cannot be realized, at least in the manner first chosen. If the inductance of the modulation was of low reactance the dynamic characteristic may appear as an ellipse, with time advancing with the points of the curve going counter-clockwise. Increasing the reactance of the modulation reactor will close this ellipse and the dynamic curve approaches a single line.

Next check the dynamic characteristic for symmetry by reading the grid voltage difference between the operating point and one extremity of the dynamic, and comparing it with the grid voltage difference from the operating point to the opposite extremity of the dynamic curve. If the voltage on one side of the operating point exceeds that on the other by more than 5 per cent, the allowable distortion limit tolerated in usual practice has been exceeded and the dis-symmetry must be reduced at least to the 5 per cent value. Examination of the static and dynamic curves will reveal immediately how much the operating point must be shifted to accomplish the correction, how much the inductance must be increased to bring about a given correction in phase angle or distortion of the dynamic curve. Correct the originally calculated values of currents in the various circuits to agree, replot the dynamic to their final values and the design of the modulator for a given performance is complete.

Typical general dynamic conditions are shown in the appended figures, one of which is in rectangular coordinates, the other in vector form.

Once the modulator dynamic characteristic has been calculated for the lowest modulation frequency, and the circuit constants for modulator and amplifier circuits are known, the designer can investigate the audio fidelity. In this work the actual physical characteristics of the modulation reactor, and the actual impedance of the load circuit, must be considered. The impedance of the modulation reactor will change with frequency and with the amount of d.c. passing through it. As its inductive reactance tends to rise with frequency, and the effect of distributed capacity is the opposite, so that actual measured values of impedance should be employed. While at low frequencies the oscillator or amplifier load, R_o, may be essentially pure resistance, there will be a departure from this condition at the higher frequencies because of the parallel capacitance in the r-f circuits. The values normally used for these condensers have low reactance, compared with R_o, at, say, 10,000 cycles. Hence this capacitive effect must be taken into account in accurate designing.

The audio characteristic is found by taking a given modulator exciting (grid) voltage, held constant at all frequencies, and calculating the dynamic characteristic for a number of frequencies.

Thyratron control of welding in tube manufacture

By H. W. LORD and O. W. LIVINGSTON

General Electric Company,
Schenectady, New York

VACUUM tube manufacturers probably use spot (resistance) welding more than any other single industry. The welds required in assembling a vacuum tube are many and varied and the metals involved are often such as to make difficult the accomplishment of consistently strong welds.

Electronic tubes entered the field of resistance welding several years ago when the noisy and troublesome contactor necessary on high capacity welders was replaced by a series transformer with a pair of power Thyratrons shorting the secondary.[1] Further increase in control technique was obtained by the substitution of a Thyratron synchronous timer for the cam operated control switch.[2] These circuits, while applicable to the small welders, were developed primarily for high kva. capacity welders with a correspondingly high cost. This article will be limited to a new circuit for low capacity welders and the extent to which it fulfills the requirements of an ideal welder.

If we have an ideal welder it will consistently produce ideal welds of the following characteristics: The metal at the points of contact should be heated to the plastic state and the pressure made sufficiently great to press the two pieces together in a forging manner that binds them to each other with a bond at least as strong as the single pieces; no change in heat treatment or oxidation should take place except at the welded point.

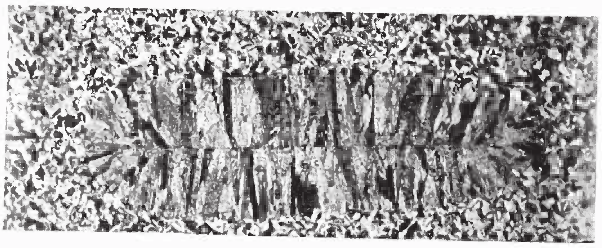
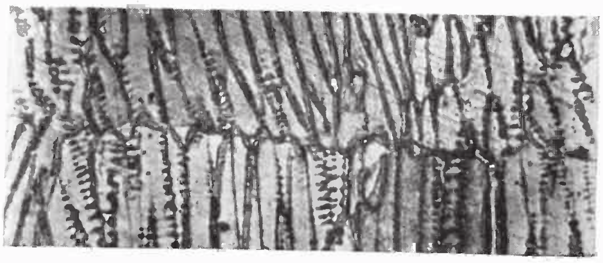


Fig. 1—Photomicrograph of welds on stainless steel. Upper figure, magnified 50; lower 1200 diameters



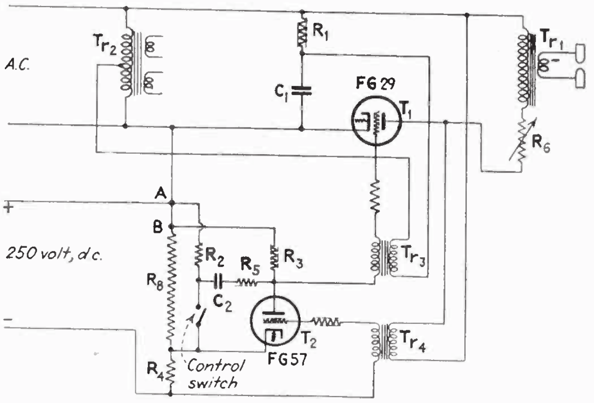


Fig. 2—Circuit used in the grid-controlled rectifier welding control

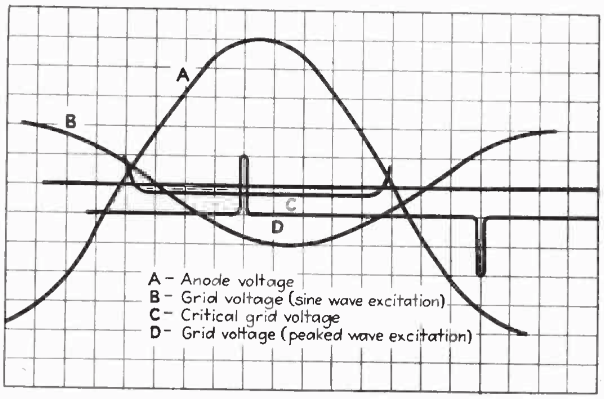


Fig. 3—Types of grid excitation for controlling thyratron

A photomicrograph of an ideal weld on .037 in. stainless steel is shown in Fig. 1. This shows a cross section magnified 50 diameters. The sharply defined line down the center leads one to believe that the weld is weak at this point, but in a section of this line magnified 1200 diameters crystals may be seen completely crossing the line, indicating a strong weld.

To prevent change in heat treatment or oxidation at other points the heat should be confined to the point of welding by applying the welding current for comparatively short times. At the short welding times accuracy is extremely important since a fraction of a cycle may be a large percentage of the total welding time.

The ordinary spot welder does not produce ideal welds for several reasons. With manual control the welding time is necessarily long and relies on the operator's judgment, taught only by experience. If the judgment factor be removed by controlling the welding time by time delay relays, the welds still must be made in comparatively long times owing to the non-synchronous action of the contactor destroying the accuracy when short times are attempted. Synchronous motor driven contacts have been used but, even with most careful adjustment, occasional sparks occur which are detrimental to the contacts as well as the accuracy.

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[1] Thyratron Control Equipment for High Speed Resistance Welding Equipment—G.E. Rev.—R. C. Griffith—Sept. 1930.

[2] Thyratron Control for Resistance Welding Machines—Welding—Samuel Martin, Jr.—May and June 1932.

Grid-controlled rectifiers substituted for contacts provide the synchronous feature by their inherent property of ceasing to conduct only when the current stops and may be made accurate by proper control of the starting time.

Thyratron welding control circuits

The simplest circuit is obtained when the contactor is replaced by a single tube, thus restricting the welding times to one-half cycle or less. The essentials of such a circuit are shown schematically in Fig. 2.

In the circuit tube T_1 replaces the contactor and T_2 controls the grid of T_1. In the "off" position T_2 is conducting and the d-c negative bias on T_1 is equal to the voltage drop across resistor R_3. An a-c bias, leading by approximately 160 degrees and supplied by transformer Tr_3 from the phase shifting circuit composed of capacitor C_1, resistor R_1, and the primary center-tap of transformer Tr_2, is also impressed on the grid of T_1. This bias has no function in the "off" position. With T_2 conducting and the control switch open, the capacitor C_2 is charged through resistors R_2, R_5, and T_2 to a voltage approximately equal to the voltage across R_3 and of a polarity such that the terminal connected to the anode of T_2 through resistor R_5 is negative. Closing the control switch to make a weld connects the positively charged terminal of capacitor C_2 to the cathode of T_2 and the anode of T_2 is drawn negative for a time long enough to commutate this tube. Capacitor C_2 then discharges through resistors R_5 and R_3 and recharges through these resistors to the reverse polarity. When C_2 has become very nearly charged to this new polarity the voltage drop across R_3 is low and thus T_1 has practically no d-c bias. As the d-c bias approaches zero, a condition is finally reached as shown on Fig. 3. Curve A represents the anode voltage of Thyratron T_1, curve B the a-c grid voltage, and curve C the critical grid voltage. With zero d-c bias the curves show that due to the a-c grid voltage leading the anode voltage by 160 degrees there is only a 24 degree firing angle. This means that if the d-c bias is sufficient to hold T_1 off for the first 24 degrees of the positive half-cycle, it will not "fire," even though the d-c bias drops to zero immediately afterward, until the beginning of the next positive half-cycle. Tube T_1 then carries current for practically the full half-cycle or not at all. (If it is desired to have the firing angle smaller, the a-c grid voltage may be increased and the phase of this voltage advanced until it is within a few degrees of 180 degrees leading.) The firing of T_1 excites the primary of the welder transformer and refires T_2 by the voltage impressed on the grid of T_2 through transformer Tr_4, biasing T_1 off before the start of the next positive half-cycle. Opening the control switch allows capacitor C_2 to recharge to the correct polarity for commutation of Thyratron T_2 upon closing this switch for making the next weld. The current flowing during the welding period may be set by variable resistor R_6.

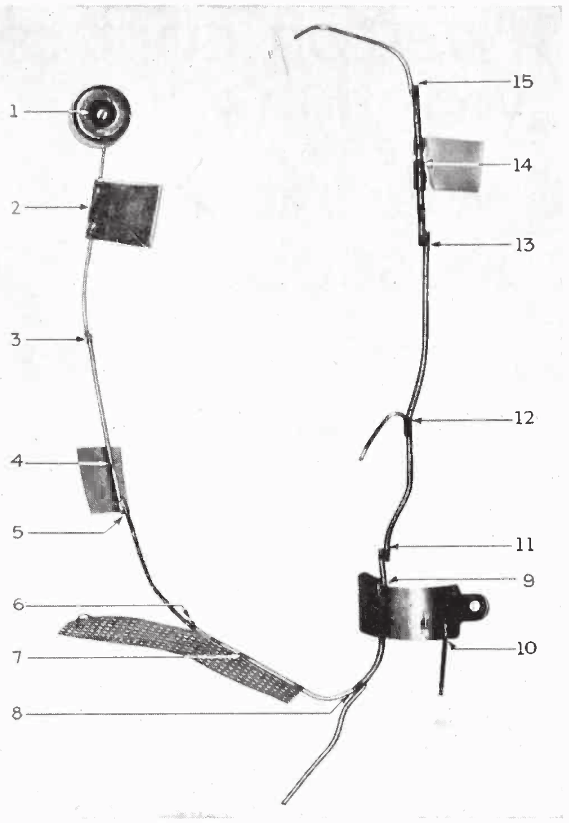


Fig. 5—Welds made with tube control

1—Copper wire and brass
2—Sheet nickel and soft nickel wire
3—Soft and hard nickel wires
4—Sheet nickel and hard nickel wire
5—Hard nickel and molybdenum wires
6—Molybdenum and invar wires
7—Perforated nichrome and invar wire
8—Hard nickel and invar wires
9—Invar wire and sheet monel
10—Sheet monel and molybdenum wire
11—Two invar wires
12—Soft nickel and invar wires
13—Invar and ascaloy wires
14—Ascaloy wire and nickel sheet
15—Ascaloy and hard nickel wires

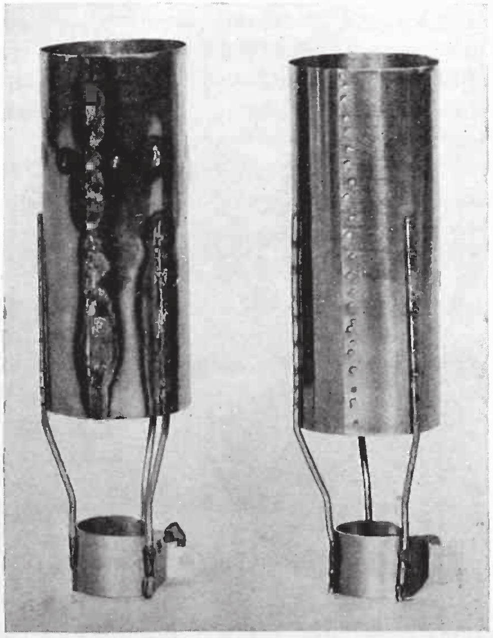


Fig. 4—Manual and tube controlled welding of thyraton grid assemblies

If it is desired to weld in periods adjustable to one-half cycle or less, the circuit of Fig. 2 may be used by inserting a resistor (R_7) between points A and B which changes the method of controlling the grid of Thyratron

[*Continued on page 206*]

Zworykin's iconoscope

Mosaic of 3,000,000 tiny photocells scanned by cathode-ray beam

Dr. V. K. Zworykin presented before the Institute of Radio Engineers at Chicago, June 26, an account of his "iconoscope," a vacuum-tube photoelectric device which greatly improves television pick-up.

The iconoscope has several striking analogies to the human eye and the human retina of light-sensitive nerve cells, which in the Zworykin device is replaced by an "electronic mosaic" of several million little photoelectric cells, on which the image falls.

Dr. Zworykin has been working on his iconoscope (literally "image observer") for ten years, the first eight years in the Westinghouse laboratories at East Pittsburgh, Pa., and the last two years in the RCA-Victor television laboratories at Camden, N. J.

Zworykin's iconoscope seems a perfect adaptation of the several principles of electronics. It is a photoelectric tube and a cathode-ray tube at one and the same time. It employs an ingenious invention, the use of a roving beam of electrons to wipe the photoelectric slate clear of its electric charges set up by the picture to be transmitted. In this erasing process the point-by-point transmission takes place.

Imagine a 4-by-5-inch plate covered by some three million of small photoelectric cells, each connected to the electrical circuit through a small capacity. A lens, external to the iconoscope tube, focuses on this plate an image of the scene to be televised—in the same way that an ordinary camera lens focuses an image on the camera ground-glass or sensitive film.

Wherever the light of a bright part of the image falls on one of these minute photo-cells, current from the cell charges the small condenser associated with the cell. Thus one has a picture or image made up of electrically charged condensers.

Now imagine a cathode-ray beam sweeping back and forth across the 4 by 5-inch plate and spraying this plate with its electron bullets. Each time an electron from the cathode-ray beam hits a charged condenser, it discharges it. This discharge current is amplified and transmitted to the receiver.

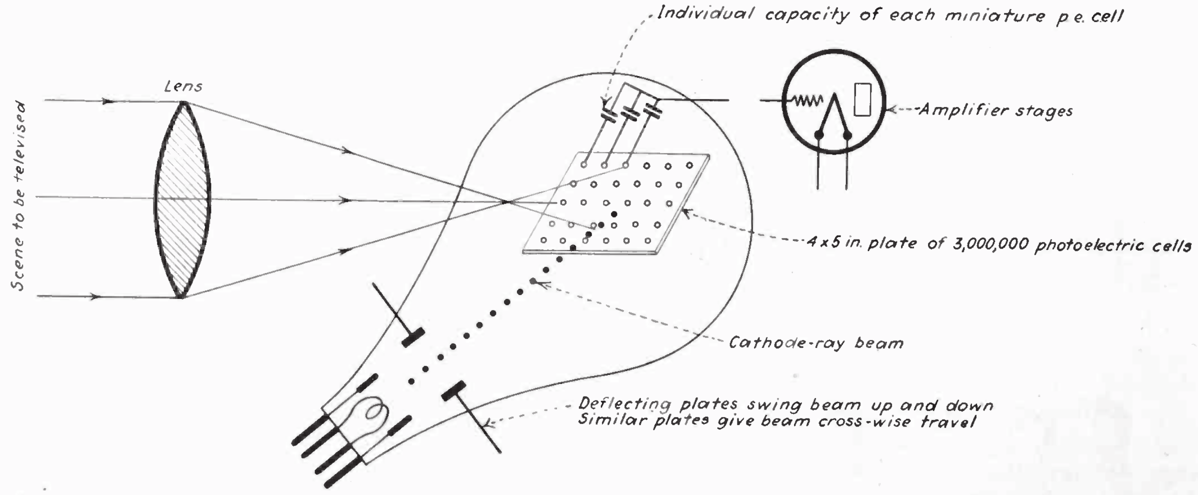
At the receiver end the incoming impulses are used to modulate another cathode-ray beam which, scanning a fluorescent screen, re-creates the original picture.

Since each photoelectric cell is extremely small (about 10,000 of them per square centimeter) the current from such an individual cell is small and the capacity of this surface to ground is very small. Therefore the time required for the "inertialess commutator" of the cathode-ray beam to charge and discharge the condenser is very small. Hence pictures with as many as 250 lines per square inch are possible.

The sensitivity of the iconoscope, at present, is approximately equal to that of photographic film operating at the speed of a motion picture camera. In its application to television the iconoscope replaces mechanical scanning equipment and several stages of amplification. The whole system is entirely electrical without a single mechanically moving part.

The iconoscope tubes measure about 16 inches long, with a bulb 8 inches in diameter, necessary to enclose the 4-by-5-inch mica sheet which carries the 3,000,000 independent photoelectric cell units.

The capacity action by which the individual photocells store up electrical impulses in the condensers, has been likened to a kind of "electronic memory," by which the images are being continuously gathered and reinforced, between the successive passages of the discharging cathode-ray beam.


Individual capacity of each miniature p.e. cell
Lens
Amplifier stages
Scene to be televised
4x5 in. plate of 3,000,000 photoelectric cells
Cathode-ray beam
Deflecting plates swing beam up and down
Similar plates give beam cross-wise travel

The image of the scene to be televised is focussed on the 4-by-5-in. plate made up of 3,000,000 individual photosensitive cells. Each cell, when illuminated, stores its photoelectric charge in its associated condenser. The cathode-ray beam, sweeping the plate, discharges these condensers, producing impulses which are then amplified

Sodium-vapor lamps supplied from alternating-current circuit and used to light auditorium during industrial conference at Andover, N. J., addressed by Dr. J. W. Marden, Westinghouse research engineer

Sodium-vapor illuminants

New high-efficiency Philips, General Electric and Westinghouse lamps shown

LAST month "made history" in the introduction of new high-efficiency sodium-vapor illuminants into the United States. For a long time the high illuminative power of the sodium lamp has been known, but its commercial introduction waited on the development of a special glass that would resist the destructive action of the sodium at the high temperatures involved. Sodium-vapor lamps for outdoor highway lighting, for a year, however, have been installed on a large scale in European roads, particularly in Holland, Switzerland, Denmark, Sweden and England (see *Electronics,* August, 1932, page 253).

The first of the European sodium-vapor lamps to be shown in America was exhibited on June 14 before the New York Electrical Society. This lamp consumed about 80 watts and produced 500 cp. Its efficiency is about four times that of tungsten-filament lamps, but owing to its monochromatic light, the greater acuity makes four to five times as "good seeing," according to Dr. Holst of the Philips laboratories at Eindhoven, Holland, where the lamp was developed. Thus the gain in "seeing" power may reach 15 to 20 times that for the same energy applied through present street lamps.

Between Schenectady and Albany, the General Electric Company has installed half a mile of sodium-vapor lighting, employing 22 of its own new units. These lamps consume 80 to 90 watts, and produce 4000 lumens. The lamps measure 7 inches long, and 3 inches in diameter, and are enclosed in double-wall vacuum jackets, becoming literally "lamps in thermos bottles" to preserve the high internal temperature, 480 deg. Fahr. The lamps start with a neon glow, the familiar red color turning to the bright yellow of sodium as the lamp warms up. This yellow color is near the point of maximum sensitiveness of the eye, which accounts for the remarkable acuity of vision possible with the new lamps. The color is however objectionable for general lighting purposes, and it is likely that principal uses will be outdoors, for roadways, playing fields, tennis courts, etc.

In the Schenectady installation, the direct current 5-amp. series circuit is supplied by a thyratron tube, operating from a 700-volt alternating-current supply, stepped down from 2300 volts.

At Andover, N. J., the hall in which the New Jersey Industrial Conference met June 18, was lighted by Westinghouse sodium-vapor units as pictured on this page. Dr. Marden, associate director of research for the Westinghouse Lamp Company, also demonstrated a new cadmium-vapor lamp, the predominant red light of which restored the naturalness of flesh color, which was lost under the sodium illumination.

"The sodium-vapor lamp," said Dr. Marden, "is the most efficient source of illumination yet produced. It gives 40 to 60 lumens per watt as compared to perhaps 15 lumens per watt for ordinary tungsten. Any immediate practical use will probably occur where the color is no obstacle, but where the high visual acuity permits handling small objects and making close inspections in various branches of industry."

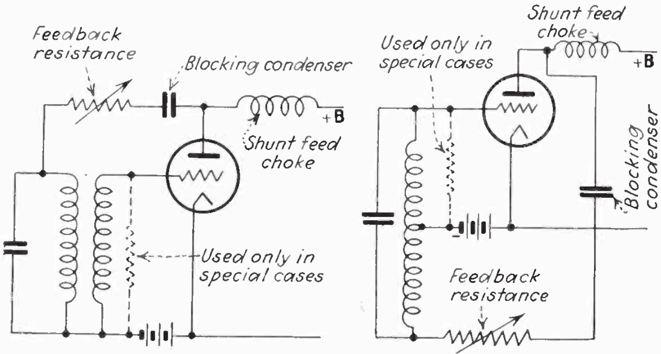
THE CHARTS ON THE FRONT COVER

"Ten Years of Radio Receiver Manufacture," the charts on the front cover, were compiled by Ralph H. Langley, radio consultant, 165 Broadway, New York City. The uppermost two graphs, total retail value and total number of sets sold annually, are from McGraw-Hill figures, collected annually by Radio Retailing and Electronics. For the total number of radio-set models each year, Mr. Langley drew on his own sources of information. The bottom curve, number of radio-set manufacturers, shows somewhat lower numbers than the corresponding McGraw-Hill records, but it is recognized that agreement here is a matter of definition. Certainly Mr. Langley's curve shows the general trend.

Resistance stabilized oscillators

By F. E. TERMAN
Stanford University

RESISTANCE stabilized oscillators are used in practically all of the beat-frequency and tuned circuit type of laboratory audio oscillators now on the market, and also are employed throughout the Bell System for generating carrier frequencies. They are characterized by a frequency that is virtually independent of tube voltages, and by an almost pure sinusoidal wave form. In spite of their usefulness, however, there is no published information available covering the design principles involved.



(a) Feedback Circuit (b) Hartley Circuit

Fig. 1—Two typical oscillator circuits provided with resistance stabilization

Two typical resistance stabilized oscillators are shown in Fig. 1. It will be observed that these are ordinary oscillating circuits with the addition of a "feedback" resistance located between the plate of the oscillator tube and the tuned circuit. This feedback resistance should be as high as possible, and will commonly be in the order of 50,000 to 500,000 ohms. Its purposes are two-fold. It makes the resistance which the tuned circuit sees when looking toward the plate substantially independent of the electrode voltages because the plate resistance of the tube is only a small fraction of the total. Secondly, the feedback resistance limits the amplitude of oscillations to the straight line parts of the tube characteristic, so that practically no harmonics are generated.

The fundamental principles involved can be understood by the following consideration. If oscillations can exist at all they will begin with minute amplitude and will then build up until the grid draws current. This grid current introduces energy losses that increase rapidly as the oscillations become larger, and an equilibrium is finally established. If the feedback resistance is so high that oscillations are barely able to exist with no grid losses, then equilibrium will be reached at an oscillation amplitude which drives the grid only slightly positive. The crest a-c voltage which the oscillator applies to the grid under these conditions will be slightly (about 25 per cent) more than the grid bias.

The wave form is determined by the linearity of the tube's dynamic characteristic over the range of a-c voltages which the oscillations apply to the grid. It is apparent that if a good wave form is desired, the tube when considered as an amplifier must be adjusted so that it amplifies without distortion an a-c voltage on the grid having a crest value slightly greater than the grid bias. This means that the oscillator tube should be operated at a grid bias that is slightly less than the grid bias that would be used for Class A amplifier operation at the plate voltage employed.

While the feedback resistance is the most important single factor controlling the frequency stability of the oscillations, there are other factors that should be considered. In particular, the coupling between the grid and plate coils of the oscillating circuit should be as close as possible.[1] A good wave form also increases the frequency stability since harmonic currents will encounter reactive load impedances, and so consume reactive energy which must be supplied indirectly from the fundamental frequency of the oscillations.

The feedback resistance must be non-inductive and is commonly made of composition units. When the frequency is to be varied the feedback resistance should be tapped so arranged that each added step increases the total resistance 10 to 20 per cent. At audio frequencies resistances up to about 500,000 ohms are permissible, but at radio frequencies lower values, as 100,000 ohms, should be used to avoid trouble from stray shunting capacities. In the event that these maximum values of resistance are not able to limit the oscillation amplitude sufficiently, a high resistance should be shunted across the grid coil as shown dotted in Fig. 1. The blocking condenser in series with the feedback resistance should have a low impedance to the lowest generated frequency compared with the minimum feedback resistance.

The most satisfactory type of oscillator tube is one having an amplification factor of 6 to 10, combined with a low plate resistance. The 112-A tube is excellent, and the 27, 26, 37, etc., are also good. With such tubes the ratio of grid turns to plate turns is customarily near unity.

The shunt feed choke must have a high reactance compared with the plate resistance of the tube if phase shifts that impair the frequency stability are to be avoided. This means that the choke must be a good one and that the tube should have a low plate resistance. At radio frequencies the choke can be resonated with stray and tube capacities to advantage.

For frequencies up to several hundred cycles ordinary transformer iron cores are excellent. At higher frequencies it is possible to make satisfactoy coils with thin laminations, while iron or permalloy dust rings are even better. At radio frequencies air core coils must be used even though they do not permit as close coupling as do magnetic cores. Good paper condensers are satisfactory for tuning purposes. Excellent frequency stability will be obtained if the Q of the tuned circuit is in the order of 25 to 40, while values as low as 15 are usually permissible for the extremes of the frequency range.

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[1] See F. B. Llewellyn, "Constant-frequency Oscillators," *Proc. I.R.E.*, vol. 19, p. 2063, Dec. 1931.

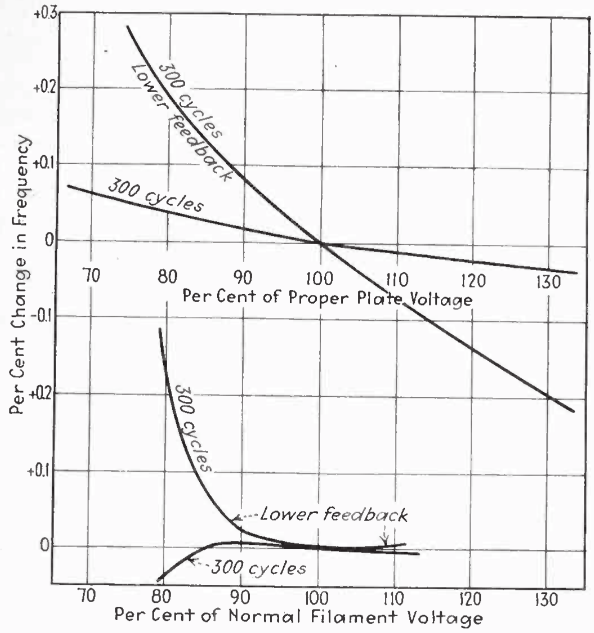


Fig. 2—Frequency stability of typical resistance stabilized oscillator

When the characteristics of the oscillating circuit are known it is possible to lay out a resistance stabilized oscillator on paper and predict accurately the amplitude of oscillations and the circuit conditions required for proper operation. For example, assume that it is desired to set up a feedback circuit such that at the frequency of operation the parallel impedance of the tuned circuit at resonance is 50,000 ohms. Assume further that the ratio between grid and plate coils is 1 to 1 and that a 112-A tube operated at a plate potential of 110 volts is to be employed. The first step is to select a grid bias slightly less than that normally used for amplifier operation at the same plate potential. A value of –5 is satisfactory; it must be obtained from a battery or a bias resistance, as grid leak bias is not allowable in the resistance stabilized oscillator. The amplitude of oscillations between the grid and cathode will be about 25 per cent greater than the bias, or roughly $6\frac{1}{4}$ volts crest.

The feedback resistance that will just barely enable oscillations to start has such a value that when 1 volt is applied to the grid of the tube, exactly 1 volt will be developed across the tuned circuit by amplifier operation. Assuming a good choke the feed-back resistance at which oscillations will just start is given by the formula

$$\left(\begin{array}{l}\text{Starting feedback}\\ \text{resistance}\end{array}\right) = R_L\,(\mu-1)-R_p \qquad (1)$$

where R_p is the plate resistance of the tube, R_L the load resistance offered by the tuned circuit, and μ is the amplification factor of the tube. With $\mu=8.5$, $R_p=5000$, and $R_L=50{,}000$, the critical feedback resistance works out to be 370,000 ohms. The value actually employed should be about 10 to 15 per cent less than this or roughly 325,000 ohms. In the event that a resistance such as shown dotted at Fig. 1 had been placed between grid and cathode, this would have the effect of lowering the effective parallel impedance of the tuned circuit and would lower the proper feedback resistance accordingly. The feedback resistance is usually adjusted experimentally by setting it on the first tap below the one at which oscillations start, but calculations such as outlined above are of considerable aid in establishing the limiting values that will be needed.

It is also possible to predict the grid current with fair accuracy. Thus in the above case, when equilibrium is established with a feedback resistance of 325,000 ohms, the effective load resistance (including the effect of grid losses) is found from Eq. (1) to be 44,000 ohms, which means that the grid losses are equivalent to shunting 366,700 ohms across the grid coil. Since the grid current flows in impulses at the crest of the cycle when the a-c voltage is nearly $6\frac{1}{4}$ volts in amplitude, the average grid current is approximately $6\frac{1}{4}/366{,}700=16+$ micro-amperes.

The resistance stabilized oscillator may be coupled to an output tube by connecting the two grids together or by resistance coupling to the oscillator plate circuit. The grid connection is preferable from the point of view of wave form, since it makes use of the tuned circuit voltage, which is very nearly sinusoidal, but it has the disadvantage that the a-c output voltage available is small. Plate coupling makes use of the amplification factor of the tube to increase the output voltage, but has a slightly poorer wave form since all distortion generated in the plate circuit is passed on to the output without being discriminated against by a tuned circuit.

When such an oscillator is properly built, the generated frequency is practically independent of plate, filament and grid potentials within reasonable limits (such as 10 per cent variations). The stability is so excellent that the principal factor causing frequency changes is the temperature coefficient of the tuned circuit. The wave form also appears absolutely sinusoidal when viewed in an oscillograph after *distortionless* amplification. Finally, the amplitude of oscillations depends primarily on the grid bias, and so is largely independent of frequency and plate voltage. Altogether, the characteristics of the resistance stabilized oscillator make it almost ideal for laboratory use requiring generation of frequencies below 150 kc.

That these possibilities are actually realized in practice is shown by Fig. 2 which gives information on the performance of an oscillator built in the Communication Laboratory at Stanford University, covering the frequency range 15-15,000 cycles. It uses a 112-A oscillator tube at a bias of –5 and a plate potential of about 110 volts, with a 100,000 ohm resistance shunted across the grid coil. There are three sets of coils, each having midpoint taps to give a total of six inductance values with the grid-plate ratio approximately unity. Ordinary transformer laminations are employed in the lowest frequency coil (15 to 250 cycles) while the two smaller coils are wound on permalloy dust rings.

It is seen from Fig. 2 that at 300 cycles this oscillator does not vary its frequency by more than 0.015 per cent (about one twentieth of a cycle) when the plate or filament voltages are varied 10 per cent from normal. The curve marked "lower feedback" is for a feedback resistance of 108,000 ohms instead of the proper value of about 151,000 ohms, and shows the importance of using the highest possible feedback resistance. The Q of the tuned circuit at 300 cycles was between 20 and 25. At 1000 cycles where the Q was about 50 the frequency stability was increased to 0.01 per cent for 10 per cent changes in plate and filament potentials.

HIGH LIGHTS ON ELECTRONIC

Variable speed motor with vacuum tubes

A SYNCHRONOUS MOTOR operating efficiently at variable speeds by means of a new type vacuum-tube control was demonstrated in the General Electric test laboratories at Schenectady, to the 300 delegates attending the northeastern Spring meeting of the American Institute of Electrical Engineers. The new control, a development of Dr. E. F. W. Alexanderson, has many important uses in the electrical industry where it is desired to operate alternating current motors at various speeds with remote control.

An important field promises to be the electric ship. Steam turbines operate most efficiently at full speed. To slow down the propeller motors, it is necessary to slow down the turbines. With the new equipment the turbine operates at one speed at all times, and the speed of the propeller motors can be varied by changing the frequency of the current fed to them through the vacuum-tube control. Instead of the captain communicating orders to the engine room for a change in speed, the new apparatus makes it possible for him to regulate the speed of the driving motors directly from the bridge.

The equipment demonstrated consists of a 400-horsepower motor and 18 Thyratron tubes. Power is fed into the bank of tubes directly from a 4,000-volt line. The tubes convert this power into different frequencies before it is delivered to the motor. This varying frequency in the current results in varying speeds of the motor.

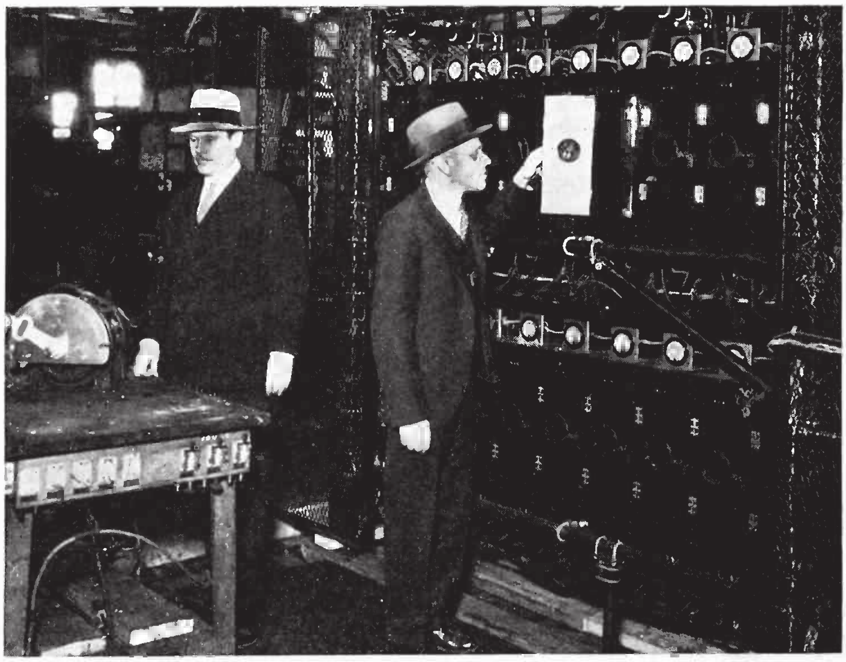
"The tubes, in changing the frequency of the current, perform the function of a commutator," Dr. Alexanderson explains. "The grid control makes it possible to start with full torque from standstill and to operate the motor at any desired speed without wasting power in resistance.

"Much engineering work is still ahead of us. However, I feel this development points the way to a new era in the electrical industry, in which many important functions and power transformations will be performed by vacuum tubes. With commutator motors, the efficiency between power lines and the motor shaft is now about 90 per cent; with the tube control this efficiency will be raised to about 98½ per cent."

Tubes in rubber making

BY IMBEDDING the two grid condenser plates of an oscillator in a mass of rubber undergoing vulcanization, one rubber company has been able to follow closely the progress of the vulcanization reaction. As sulphur added to the rubber, the dielectric constant of the mass changed sufficiently to cause frequency variations in the oscillator circuits which could be interpreted in amounts of combined sulphur.

Oscillations of various frequencies are also found to have catalytic effects on many of the more common chemical reactions.



By means of eighteen thyratrons this 400-hp. synchronous motor fed directly from a 4,000-volt line gives ready adjustability in speed

Surgeon's approach opens operating-room door

RECOGNIZING THAT AFTER A surgeon has sterilized his hands and gloves preparatory to an operation, the touching of an operating-room door may transmit germs that negative all the precautions that have gone before, photo-cells are now being recommended for this important service of opening operating-room doors without touch or noise, at the mere approach of a surgeon or nurse.

A striking demonstration of this novel use of photo-cell control is contained in the model operating room at the Chicago World's Fair. A beam of light operates the door of the room, by merely stepping across it, so that the door is opened without even the touch of a sterilized glove.

Another electronic application in this model operating room is the system of microphones and loudspeakers by which every sound of the surgeon's voice is heard by the gallery of spectators above the operating table, although plate-glass shuts off the gallery and any possibility of infecting germs reaching the operating table.

Photocell mine doors speed haulage, save power

AT THE CONVENTION OF the American Mining Congress held at Pittsburgh, Pa., in May, a model of the photoelectric mine-door control of the Nemacolin mines of the Buckeye Coal Company was demonstrated, based upon the action of the electronic control as used in the actual mine.

As the mine locomotive approaches the mine door, it intercepts a light beam initiating the control operation which opens the door. After the train has passed, another light-source on the opposite side casts its beam on a phototube motivating the controls for closing the door. The system is so interlocked that the operations cannot take place in any manner than their predetermined sequence. The light beams are projected at an angle from the track in such a way that the light will not shine between the cars.

With a photocell control of this kind, declares G. E. Stoltz of the Westinghouse mine-electrification department, coal transportation underground need no longer wait on the opening and closing of mine doors. The train does not have to slow down. Increased haulage speeds are maintained, and accelerating power is saved.

DEVICES IN INDUSTRY + +

Theaters use a photoelectric drinking fountain

PHOTOELECTRIC DRINKING FOUNTAINS have proved great attractions in several Chicago theaters. Using photoelectric equipment, such installations inject an element of mystery into the simple action of getting a drink. No handles are to be found at these fountains, but when patrons bend over to drink, the water flows automatically until the person straightens up.

The illustration appearing on page 79 of March *Electronics*, showed the photoelectric fountain at the Granada Theater, Chicago, employ G-M Laboratories apparatus. A second unit is at the Oriental Theater in the heart of Chicago, and the third is at the Southtown, the new Balaban-Katz wonder theater on the south side. In each of these photoelectric installations existing fountains were used with standard photoelectric control equipment.

The light beam is projected through an opening on one side of the fountain and is reflected onto the photoelectric cell behind the lower opening by means of a mirror mounted in the right hand pillar. Interruption of this light beam controls the flow of water.

◆

Multi-photocell counter checks up theater admissions

THE ELECTRO-SOUND PRODUCTS COMPANY, 317 Jackson Ave., Long Island City, N. Y., has developed a theater-attendance "checker" or counter which appears to be almost unbeatable in its accuracy in counting persons passing through its doorway, whatever their efforts to produce errors.

The doorway through which the entering traffic passes is spanned by some twenty or more beams of almost invisible blue light, focussed on photocells which operate interlocking relays. The counter is not operated by persons passing in the reverse direction. It counts correctly persons entering arm-in-arm, groups passing through in lockstep, persons carrying umbrellas or coats in front of them, and other situations which ordinarily cause false counts with ordinary single-beam counters.

Such a theater traffic checker is useful not only for preventing the double sale of tickets through collusion between the cashier and ticket-taker, but is also important in the case of percentage contract between film-owner and theater operator, where the film concern is entitled to a share of the door receipts. With such a checker a daily sealed record of attendance at the theater can be prepared.

Experience so far seems to show that the checker is "without error," even under the most severe door-traffic conditions. Test installations have been made so far at the Arcadia Theater, The Bronx, New York City; the Queensboro Stadium, Queens Plaza, Long Island City, and the Didsbury Theater, Walden, N. Y.

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Restaurant door opens when guest approaches

ONE OF THE LATEST installations of "Magic Doors" made by the Stanley Works of New Britain, Conn., is shown in this photograph of The Susan Palmer Oyster Bar and Restaurant at the corner of Fifth Ave. and 49th St., New York City.

As far as is known these are the first entrance doors in the world to be sold as a commercial article to a restaurant owner. The entering light ray shines from the vestibule wall to a photo-cell in the railing. The exit light ray shines from the left-hand post to a photo-cell in the right-hand post.

New problems were encountered over the familiar restaurant kitchen service door, such as wind pressure at the street intersection, heavy combination metal and plate glass doors, danger of a customer walking up to the wrong door and being hit, and proper housing of the operating mechanism for appearance and for operating under widely varying temperatures. While a kitchen service door may be hooked open in case of failure, these doors have to swing as freely by hand as any other door on account of fire and so as not to inconvenience the customers.

High-frequency waves kill pests in beans

J. H. DAVIS, chief engineer of electric traction for the Baltimore & Ohio Railroad Company, who is carrying on extensive tests with high-frequency radio waves (20-kw., 6 meters) for the extermination of insect pests in foodstuffs stored in warehouses at Baltimore, comments as follows on the success of his method as applied to beans, peas and other similar vegetables:

"From our experiments here in Baltimore, we believe infested beans respond nicely to this method of insect extermination. It appears to us, based upon our research work, that one great field of usefulness for this method of treating infested materials will be for beans, peas, and similar products. Indications are also, that this method of treatment, sufficient to exterminate insect life, will promote plant germination and growth.

"Some very eminent authorities on food values are now carrying on a series of tests for us, to determine the effect of this treatment upon the food value. We have already received reports concerning this phase of the matter indicating that in general the food value of the loaf made from wheat treated by us, was very satisfactory."

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Comparing "amount of ink" in printing book-forms

BOOK PRINTERS HAVE ALWAYS experienced difficulty in printing the various "forms" of a book to the same degree of weight of ink. Often one "form" will be printed light, another following form will be considerably darker, and still other forms darker yet. Except for the printer's eye, no scale of standards of depth of printing has heretofore been discovered, and if the practical pressman viewed his work under differing illuminations, he was likely to misjudge the intensity or depth of printing he was using.

To set up a positive standard for depth of printing, an American Photoelectric reflectometer has now been used with considerable experimental success. With this instrument a two-inch circle of the printed page is compared with the same paper unprinted or blank. Taking the blank paper as 100 per cent, a "dark" or heavy-inked page gives a reflecting factor of 85 per cent; medium gives 86½ per cent; and very light inking gives 88 per cent. Of course the sample included in the two-inch circle must in each case be of fairly solid and comparable type composition.

+ + ELECTRONIC NOTES

Night radio effects

NIGHT RADIO EFFECTS have been reproduced on 4-cm. waves by P. Keck and J. Zenneck, of the Munich Institute of Technology. One of the main effects shown by broadcast waves is that the long path parallel to the earth's magnetic field which the skywaves follow at night produces a distinct rotation of the direction in which the electric oscillations take place. Neon or argon, at pressures below 1/1,000 mm. mercury, in a container of 20 cm. diameter and 25 cm. length with plane ends is ionized by means of an electrodeless discharge; a magnetic field is produced parallel to the length of the container, and damped electric waves from a spark gap are sent through it in the direction of the oscillations of the electric force taking place perpendicularly to the magnetic field. The free electrons in the discharge, at a concentration of 30,000 million electrons per cu.cm., are set in motion by the waves, and this, despite the small weight of the negative charges, causes partial absorption of the waves and a rotation of the direction of vibration (polarization) which is the more pronounced the longer the path. The value of the angle *(Annalen der Physik 15: 903–925, 1932, and Hochfr. u. El. Ak. 40: 153–158, 1932)* found (10 to 40 degrees) is in accordance with the ionic theory of the propagation of radio waves in the higher atmosphere.

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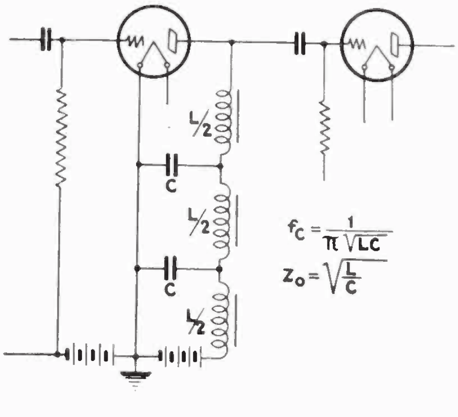
Filter-type interstage amplifier coupling

By WALLACE G. STONE

THE BASIC CIRCUIT OF an amplifier[1] using a low-pass filter to couple the tubes together is shown in the figure. It will be seen to consist of a mid-series termination filter. Such a filter has the characteristic of reflecting all frequencies above a certain cut-off frequency without alteration of form. Its effective impedance is many times its characteristic impedance at any frequency appreciably above the cut-off frequency even if not more than one and one-half sections are used. Z_o is the d-c resistance of the tube.

In a typical amplifier of this type consisting of three stages with one and one-half sections of filter in the plate circuit of each stage with a cut-off frequency of 20 cycles, the gain using old types of tubes was 66db, the maximum variation from 30 to 7,500 cycles was 1 db and up to 15,000 cycles the maximum variation was 5 db. The input impedance was 100,000 ohms, the output impedance was 4,000 ohms.

In an amplifier for a public address system with an output of 10 watts the largest choke was a 530 henry, 5 ma. winding, the others being smaller in inductance but carrying somewhat more current. It is an error to assume, as some have done, that if values of inductance of this order are used it is unnecessary to bother with making a filter. If a 92.5 henry choke is used without bothering to use it in the form of a filter the ratio of reflected energy to lost energy at 60 cycles when used in the plate circuit of two 45-type tubes in parallel is about 12 db. against 76.5 db. when used in the form of a filter.



Low-pass filter coupling

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[1] U. S. Patent No. 1,869,715 to Winfield W. Salisbury.

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A new impedance measuring device

By ALFRED W. BARBER

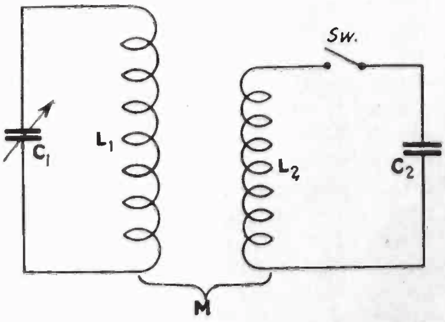
BRIDGE MEASUREMENTS OF capacity and inductance are familiar to every engineer. Rough measurements by bridge methods are easily made but for precision, many precautions must be taken and often elaborate apparatus is required. To equip a laboratory with a number of special purpose bridges is expensive and bridges covering wide ranges are not highly accurate or are unduly complicated and difficult to operate.

Beat frequency methods which have been used to compare two equal capacities are easy to operate and give accurate results but are limited to the range of the standard which is usually about 1000 μμf. By the introduction of a ratio coil and a novel method of zero beat indication, it is possible to extend the range of measurement while retaining the ease of operation and precision inherent in the best frequency method.

In a self-contained instrument, a reactance measuring device covering a range of 1 to 5,000,000 μμf. and 1 to 1,000,000 microhenries is possible. The only external connections are to the 110-volt line, a pair of telephones and the unknown reactance.

To compare an unknown capacity with a known change in capacity of a standard condenser by beat frequency methods, it is necessary to have two oscillators and a detector. One oscillator is maintained at a fixed frequency and the other oscillator is tuned to it by means of the standard condenser C_1. Zero beat may be detected by means of the telephones in the plate of the detector which receives voltage from both oscillators. The unknown capacity C_2 is then connected in parallel with the standard condenser and the latter reduced in value until zero beat is again obtained in the telephones. The difference in capacity of the standard between its initial and final values is then the capacity of the unknown. If the oscillating tubes do not change frequency due to line voltage variations or heating while a reading is being taken, the accuracy with which the unknown may be found is very high and is of the order of the accuray with which the standard condenser may be read.

The figure is the basis for a system in which the unknown reactance may be larger or smaller than the standard. L_1 represents the primary of an ideal transformer, L_2 represents the secondary and M the mutual inductance between primary and secondary. If variable condenser C_1 is across the primary and L_1 is in series with the plate of a dynatron, the frequency of oscillation with switch Sw. open will be closely $F_1 = \frac{1}{2\pi\sqrt{L_1C_1}}$. Now if the secondary



Circuit for measuring reactance

FROM THE LABORATORY ++

is coupled to the primary 100%, i.e., so that $M = L_1L_2$ and we close switch Sw., the frequency of oscillation will become $F_2 = \dfrac{1}{2\pi\sqrt{L_1C_1 + L_2C_2}}$. If we now restore the frequency of oscillation to F_1 by decreasing C_1 to a value C_3 we have $F_1 = \dfrac{1}{2\pi\sqrt{L_1C_3 + L_2C_2}}$. Equating the two expressions for F_1 we obtain as the value of C_2, $C_2 = \dfrac{L_1}{L_2}(C_1 - C_3)$, and if the inductances of the primary and secondary coils are proportional to the square of their respective number of turns, we have the relation, $C_2 = \dfrac{(\text{primary turns})^2}{(\text{secondary turns})^2}(C_1 - C_3) = n(C_1 - C_3)$. When the secondary is equal to the primary, $n = 1$; when the secondary is larger than the primary, $n < 1$; and when the secondary is smaller than the primary, $n > 1$.

Use of transformer

By using a tapped secondary and a multi-point selector switch, we make instantly available ratio factors equal to 0.1, 1.0, 10, 100, 1000, and 10,000 or whatever ratio points are convenient. Actually, the primary coil may be omitted and the tapped secondary alone used for the ratio coil in the form of an auto-transformer.

The detection of zero beat between two inaudible frequencies by means of telephones always presents a problem since the response of telephones and ear both fall off badly at very low frequencies. A simple and effective method which permits extremely close adjustment of the two beating oscillators, consists in the introduction of a third signal into the system upon which the very low audio beats are superimposed and which then become easily detectable in the telephones. The effectiveness of the system depends largely on the frequency and intensity of the third signal.

To measure inductances with the system, the unknown condenser is simply replaced by an unknown inductance and since this increases the resonant frequency, zero beat is restored by increasing the capacity of the standard condenser. By means of standard inductances, the standard condenser may be calibrated in terms of inductance.

Although many special purpose instruments based on the principles outlined above may be visualized the device described briefly here makes a universal reactance meter of high accuracy and great ease and spread of operation.

A high gain a.c.-d.c. amplifier

By Earl R. Meissner

While tubes with a very high amplification constant have been built it is in general impossible to realize but a small per cent of their gain at zero frequency. For instance if a voltage gain equal to one half the mu of the tube is desired we must use a plate resistor which matches the plate impedance of the tube. This means for a type 58 tube a resistance of 800,000 ohms, and a battery voltage of 6,810 volts. Such a high voltage is of course impractical.

One way out of this difficulty is to use a tube having a very high plate impedance as the coupling device. Figure 1 shows such a circuit where type 58 pentodes are used. While this circuit necessitates an isolated screen and grid bias as well as a separate filament supply it does accomplish the desired results.

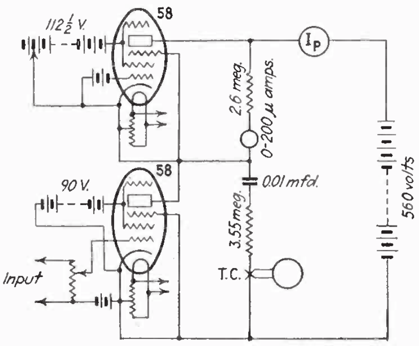


Fig. 1—Direct-coupled amplifier

The bias on the tubes is arranged so that they divide the plate voltage equally. Thus the plate voltage-plate current curves intersect at the point *a*. Now assume the bias on one tube to be increased so that its plate voltage plate current curve is represented by the curve O-E_{g_3}. Now the point where the two tubes draw equal current is shifted from point *a* to point *b*. Likewise the voltage across one tube increases to E_1 and the voltage across the other decreases to E_2. Thus for very small changes in grid voltage the plate voltage change may be very large.

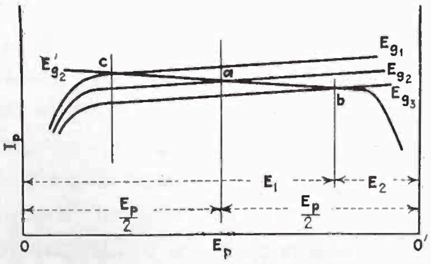


Fig. 2—Tube characteristics used

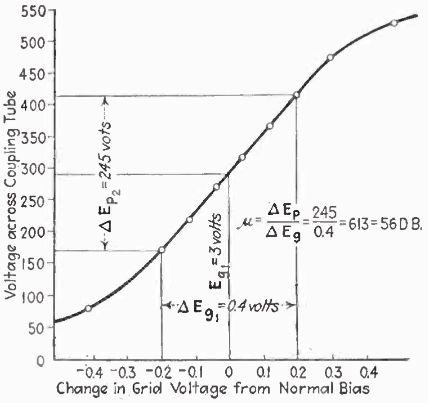


Fig. 3—Amplifier characteristic

Figure 3 shows the C_g-e_p relation. The slope of this curve represents the d-c amplification and is of the order of 610 for the tubes indicated. This is approximately half the amplification constant for a type 58, which is given as 1280.

This circuit may also be used as an a-c amplifier. A frequency curve, when operating at a gain of 56 decibels, is shown in Fig. 4. Using a coupling resistor of 64,000 ohms for the a-c component, in place of the 3.55 megohm resistor, gives a gain of 41 decibels and 10,000 cycles is down 0.9 decibels. The loss at the low end depends only upon the size of the coupling capacity. If it is desired to extend the curve down to zero frequency the coupling capacity is removed. The bottom end of the resistor is returned to the mid point of the "B" battery so as to buck out the d-c drop across tube one.

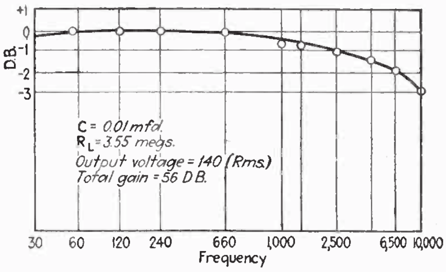


Fig. 4—Fidelity curve of amplifier

When a triode is placed in series with a pentode, practically the full mu of the triode is realized. The pentode acts as a constant current device and regardless of the impedance of the triode maintains constant current through it. Testing several triodes in this manner the author found their amplification constants to check very closely with their rated values.

electronics

McGraw-Hill Publishing Company, Inc.
330 West 42d Street
New York City

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Volume VI —JULY, 1933— Number 7

Five per cent for research

CERTAINLY that was an admirable proposal by the I.R.E. to have a percentage set aside out of manufacturers' gross sales, to be applied to research and scientific study in the art. Five per cent has been suggested, and this would not be too much, although at the present economic juncture, it may be difficult to secure approval of such a figure. On the other hand, such an amount has not been far from that assigned by notably successful corporations for their research funds.

A five-per-cent fund for research, imposed on all manufacturers of radio and allied products, would have many interesting and beneficial effects. It would aid technical employment and advance the art. And it would kill off the gyp manufacturers or force them to contribute to the art which they now benefit from but do not support.

The foreign language market for short wave sets

THERE are thousands of foreign-born people in this country that would like to hear their native language from their native land. This is possible on a good short-wave set. It is now a common thing to hear Rome, London, Paris, Berlin, Madrid very well every day one listens. News, songs of the fatherland, all kinds of talks in their own language, await the owners of a good short-wave set. But to date such sets have been mere adjuncts to a broadcast set. There is a place for a good a.v.c. set selling at from $50 to $100 and sold to foreigners through their own language newspapers and dealers.

Patents are not "monopolies"

THE recent decision of the United States Supreme Court in the so-called Lowell and Dunmore case contradicts the commonly held belief that a patent is a monopoly. The decision reads, "Though often so characterized a patent is not, accurately speaking, a monopoly, for it is not created by the executive authority at the expense and to the prejudice of all the community except the grantee of the patent. The term monopoly connotes the giving of an exclusive privilege for buying, selling, working or using a thing which the public freely enjoyed prior to the grant. Thus a monopoly takes something from the people.

"An inventor deprives the public of nothing which it enjoyed before his discovery, but gives something of value to the community by adding to the sum of human knowledge."

Long-wave vs. short-wave broadcasting

MUCH discussion has been waged on the question of widening the broadcast band by adding a few channels on longer waves. It has been suggested that some philanthropic organization undertake the construction of a super-power station on 1,000 meters or thereabouts, to get the ball rolling. Undoubtedly it would be a noble experiment demonstrating the superior carrying powers of the lower frequencies—and the louder static.

But without spending much money the stage is all set for an experiment of broadcasting on the very short waves. For coverage to the horizon, waves in the vicinity of 5 to 8 meters have been proved useful. Why not persuade the NBC to turn its programs into the two high-frequency channels of the Empire State Building transmitter? Let the home radio-set builders make receivers for these transmissions and determine experimentally how they compare in service with the regular broadcast band.

Certainly this is also ready-made equipment for an experiment with binaural transmission; perhaps it is also the ideal equipment for local coverage on low power. The 5-meter region would provide politicians with plenty of room for new stations, at least.

The "cigar-box" receiver—its place in the home

THERE can be no doubt that the new sub-sub-midget, of cigar-box dimensions, has achieved marked popularity with the public by its sheer compactness. With its inadequate baffle-area, its tone quality will always be deficient, but it is bound to find increasing demand as an auxiliary set.

In every home there is need for one or more quality radio receivers which will bring in the fine music, the great symphonies and the world's best artists, with all the fidelity that the broadcasters secure in transmitting these rich tones. But there will also be secondary points for other sets, in upstairs bedrooms, in the children's room, in the old folk's sitting room, in the kitchen, and in the new cellar gameroom.

There was an old merchandising maxim: "Every room needs an electric clock." Within the next year or two, we may witness its radio counterpart: "Every room needs a personal radio set," and should shape our marketing plans accordingly.

Indirect contributions by the photo-cell

ALL of the photo-electric cell's contributions to industrial improvement are not direct applications of the cells to machines in factories. The light-sensitive cell and electronic tube render some of their most important services to industry through quite indirect means.

For example the goggles used by glass-blowers were formerly blue-green glasses which cut down the glare from the incandescent glass, but also reduced the visibility of all objects around so as to make them almost invisible. Then one day a piece of didymium glass was being analyzed in a photo-electric spectroscope, and revealed a surprising peak of absorption completely shielding the yellow flame color of sodium, which gives the color to molten glass. Using these new didymium goggles, therefore, the glass blower has the yellow glare of the sodium glass completely cut off, but can see clearly the objects around him in the shop, by light of all the other wavelengths.

NEWS NOTES

Radio set sales, first quarter—Sales of radio sets by RCA licensees are understood to have increased to 525,000 for the first quarter of 1933, as compared with the 500,000 figure for the same quarter of 1932. The average value, however, is said to have decreased from a $27 factory price in 1932, to $14 in 1933.

Airplane beacon sends voice simultaneously—A combined airplane-beacon station which will transmit voice and directional signals at the same time, is being placed in operation at Elizabeth, N. J. This will enable pilots whose planes are so equipped, to receive weather reports and other flying information, while being guided by the visual indications on the plane's instrument board. The transmitter will be remote-controlled from the Newark flying field.

Federal decision opens sound-picture servicing—Federal Justice John P. Nields, at Wilmington, Del., has rendered a decision supporting the plaintiffs in the suit of the Stanley Company, General Talking Pictures Corporation, and Duovac Radio Corporation, against Electrical Research Products, Inc., and associated companies, in the matter of exclusive motion-picture licenses and servicing fees, imposed by the Erpi group on theater-owners using its equipment, which number some 5,000 houses. The decision opens the field to independent organizations for apparatus and repair parts. No action regarding the taking of an appeal by Erpi is reported.

Parts makers reorganize—Under direction of Chairman Leslie F. Muter, the Parts, Cabinet and Accessory Division of the RMA was reorganized June 6, during the RMA convention. The various committees with their chairmen follow: Carbon Resistors, H. E. Osmun, chairman; Wire Wound Resistors, Leslie F. Muter, chairman; Variable Resistors, Arthur Moss, chairman; Fixed Condensers, Richard A. O'Connor, chairman; Variable Condensers, Lloyd Hammarlund, chairman; Cabinets, N. P. Bloom, chairman; Audio and Power Coils and Wire, Whipple Jacobs, chairman; Transformers and Chokes, C. H. Bunch, chairman; Sockets, H. H. Eby, chairman, and Instruments, Robert Williams, chairman.

HODOSCOPE SHOWS COSMIC-RAY PATHS

In this "hodoscope" built by Dr. Charles Johnson of Swarthmore, Pa.; the grouped Geiger counters operate corresponding neon lamps so that the angular direction of each high-speed cosmic-ray particle is clearly shown to World's Fair visitors

REVIEW OF ELECTRONIC LITERATURE

HERE AND ABROAD

300-kw. transmitting tube

For the Hilversum broadcasting station, operating on a 296-meter wavelength, the Philips company of Eindhoven, Holland, has constructed a 300-kw. tube.

In this, as in all Philips' types of water-cooled transmitting valves, use has been made of the chrome-iron welding process (elaborated in the Philips laboratory) for joining the glass to the metal part of the valve-jacket a process that has given excellent results in practice; furthermore, the construction is such as to enable the cooling to be restricted to the anode, no cooling of other parts by water or air being required.

The filament voltage is about 34 volts, the filament current about 420 amperes. At an anode potential of about 20,000 volts the filament has an electronic emission of about 100 amperes. The valve, including its cooler, has an overall length of 140 cm. The consumption of water for anode cooling is 120 litres per minute.

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Penetration of different colors into the sea

[W. R. G. Atkins and H. H. Poole] To cover the range from the near ultraviolet to the deep red, the measurements in the English Channel on a steam drifter-trawler, were carried out, in the ultra-violet by means of a Burt sodium vacuum cell embedded in vaseline, in the blue end of the spectrum with a G. E. potassium cell (hydride, argon-filled and maintained in the sensitive condition by glow discharges) and for the rest of the spectrum by the use of a thin-film cesium vacuum cell CMV 6. In the ultra-violet, daylight is reduced to 1/100,000 at 30 meters below the surface, in the blue at 82 meters, in the green at 74 meters, in the orange at 26 meters.—*Phil. Trans. Roy. Soc.* London *222*:129-164. 1933.

✦

Narrow electronic beams at low gas pressure

[O. Scherzer, Research Lab. Algemeine Elek. Gesell., Berlin] It is now more or less accepted that the reduced cross-section of cathode ray beams obtained in the presence of a gas at low pressure is the result of the presence of the positive ions produced in the beam itself by the electrons. Their density in the steady state is such that the space charge which they represent drives the ions which are formed within a certain area through the area and out of the beam. On these assumptions the equation for the number of positive ions per unit volume, can be set up and solved in special cases, for instance the case where a cathode ray beam forms a succession of nodes along its path. Theoretically the outline of the beam between nodes ought to be a nearly sinusoidal curve, and the distance between nodes larger than $\frac{3.14\sqrt{m_-/m_+},}{e_P}$ where e_P is the probability of ionization.—*Zeits. f. Physik* 82:697-708. 1933.

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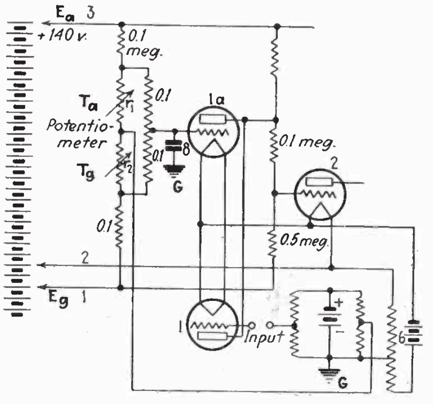
Three-stage direct-current amplifier

H. Konig, of the Swiss Bureau of Standards states that it is possible to render a three-stage d-c amplifier practically independent of the fluctuations of the several d-c sources used for its operation by applying to the grid, plate or filament of the preceding tube a fraction of the potential which is used for the grid, plate or filament of the following tube. The compensation of the fluctuations in anode and grid potential is obtained by means of a double potentiometer acting upon a first tube (1a) placed symmetrically in parallel with the input tube 1. The variable resistances r_1 and r_2 can be so adjusted that changing the anode or plate potential by two volts does not affect the output. A drop in the filament supply is counteracted through the use, in series with the A battery of a resistance one point of which is put to the ground in place of the negative pole. The lowered emission due to decreased filament current is then compensated by the drop in grid bias. Oxide coated filaments are used, for instance REO84 tubes, with an internal resistance of 10,000, G_m 1.5 ma/v, μ of 15. Together the three stages amplify 900 times d-c or a-f voltages.



New cathode ray for decimeter waves

[K. Kreielsheimer, Heinrich-Hertz Institute] At very high frequencies the potential of the deflecting plates can no longer be considered as constant during the time which the electron takes to fly from one edge of the plate to the other; the length of the plate must be so chosen that the electron enters at the beginning of a period and emerges after one (or three) quarters of the period; this condition can be obtained by proper adjustment of the plate potential. Moreover, the electrons must enter the space between the second pair of deflecting plates in the same phase in which they entered the first pair; compensation can be obtained by adding a third pair of plates. With these changes the cathode-ray tube proved to be useful down to waves below one meter.—*Ferns. und Tonf.* 4: 13-15, 1933.

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The hexode

[W. Hasenberg] Two types of hexodes have been developed by Telefunken and are also produced by Radiorohren (Valvo tubes), one being intended to take the place of the first detector tube (RENS 1224), the other to serve as exponential tubes RENS 1234 (intermediate amplifier or input tube). In this latter tube the electrons slip through the first grid at — 1.5 volt, pass through the second grid (screen, 80 volts), are stopped between the second and third grid (—1.5 volt) so that they accumulate in this space and form a virtual second cathode which is easily influenced; they are finally drawn through grid 4 (80 volts) to the plate (200 volts). Grid 1 is so wound that it produces exponential variation of the current. The mutual conductance of the tube decreases when grid 3 becomes more negative, and the result of the combination is that the mutual conductance of the tube falls from 2 ma/v to 2/10,000 ma per volt when V_3 changes from 0 to —7 volts. The capacity between the first grid and the plate is below 0.01 uuf. The second tube is a mixing tube, allowing modulation in place of addition of the two frequencies so that no overtones of the original frequency are produced.—*Funkt. Monatsh.* 2:165-173. 1933.

The inductance of by-pass condensers

[P. Kotowsky and K. Kuehn, Res. Lab. Gen. El. Co., Berlin] The impedance of fixed condensers—consisting of two metal foils separated by waxed paper, the whole rolled into compact form—drops when the frequency is increased, but starts to increase above a certain frequency, owing to the magnetic field produced by the current in the lead-in wires and the displacement and the galvanic current in the whole roll. Older types of 2μf condensers may give resonance at 900 m. The measurements show that the largest part of the inductance is due to the lead-in wires and connections. By using closely spaced wires leading from the roll or pack to the outside, the resonance frequency of 2μf condensers as used in interference eliminators can be brought to 200 m.—*El. Machr. Techn.* 10:105-108. 1933.

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Stability of two transformer-coupled tuned circuits

[J. Mercier, University of Bordeaux] The article deals with a much studied subject (see, for instance Pierce, Elec. Oscillations, McGraw-Hill). Starting with the characteristic equation of the period of the combination (see eq. 10 in Pierce, p. 96) and assuming an imaginary root as a solution (instead of a complex root in the general case), the damping coefficient ± R/2L in the first or generating circuit is eliminated and an equation of the third degree in f^2 is obtained which is studied in detail as a function of the period which the pick-up circuit would have in the absence of damping. Interesting conditions for the maintenance of oscillations occur when the separate circuits and their combination are nearly in tune. Theory and experiment illustrate how important it is to use loose coupling in measuring frequencies or in timing radio circuits as under certain conditions three frequencies are possible.—*Onde él.* 12: 93-112, 1933.

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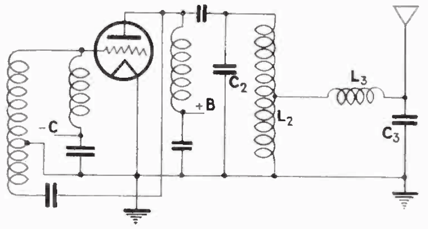
Mr. Dietsch on harmonic suppression

Some confusion may result of the drawing in Mr. Dietsch's article in June *Electronics* on methods of eliminating harmonic radiation from broadcast stations. The radio field intensity survey gives values of fundamental and second harmonic radiation. It is not made clear (the draftsman's fault!) that the second harmonic field strength is in tenths of millivolts, not millivolts.

Mr. Dietsch suggests the drawing below be followed instead of Fig. 3 in the original article. This represents a method of reducing harmonic radiation by proper design and termination of transmission line.



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The anti-fading antenna of Breslau

[F. Eppen and A. Gothe] The antenna is designed to shift the zone where interference occurs during the dark hours between the sky wave returned by the conducting layer and the ground wave away from the sender. Intensity variations may, of course, be reduced by automatic volume control but not so the distortion which is produced when the carrier wave is destroyed by interference and only portions of the side-bands remain. For the shorter broadcast waves and for soil of low conductivity, the near-fading zone moves close to the sender. For the Swiss station Beromunster (459 m.), for instance, it starts at 20 miles from the sender. The new Breslau sender (325 m.) uses a single cable of 140 m. length suspended in the center of a wooden tower as antenna. At its top the tower carries a horizontal metal ring of 10.8 m. diameter, insulated and serving as end capacity. Under these conditions a current node exists 19 m. above the ground, the antinode at 100 m. Such a structure emits less power under high angles than quarter-wave length antennas. By cutting the length down to the quarter wave, the distance where nearby fading occurred dropped from about 70 miles to 50 miles. Thanks to the use of the special half-wave antenna the area getting satisfactory reception is therefore nearly doubled.—*El. Nachr. Techn.* 10:173-181. 1933.

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Sensitivity of barrier-cells as a function of the frequency

[P. Goerlich, Zeiss-Ikon Labor. Dresden] Sinusoidal variations of light intensity obtained with the aid of a scanning disk were allowed to fall upon cuprous-oxide-copper back and front wall cells (reverse and obverse cells, see *Electronics,* October, 1932) and selenium barrier layer cells. The response of the front-wall cuprous oxide cell varies with frequency less than that of the other cells. Measurements with a vacuum tube voltmeter showed that from 100 at 100 cycles it dropped to 80 at 3,000 cycles and to 70 between 5,000 and 6,000 cycles. The sensitivity of the back wall cells increases slightly between 100 and 700 cycles. With the selenium barrier cell the response falls from 100 at 300 cycles to 90 at 1900, 80 at 3,400 and 70 at 4,600 cycles. (Selenium alone with its dark current shows a much larger effect, from 100 at 300 cycles, to 26 at 3,000 cycles).—*Zeits. techn. Physik,* 14:144-145. 1933.

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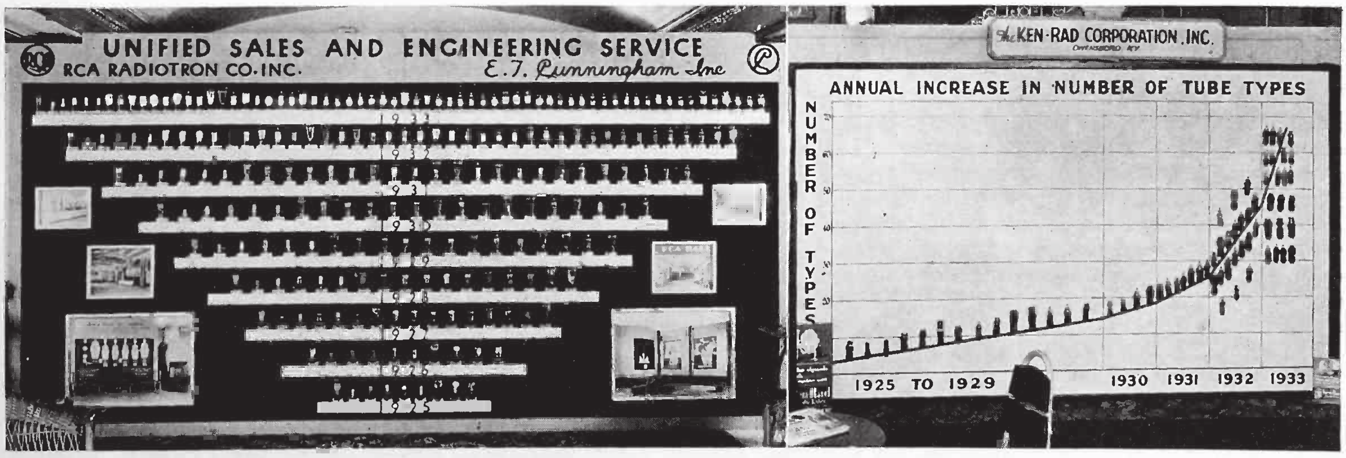
INCREASE IN TUBE TYPES SHOWN IN I.R.E. EXHIBITS, CHICAGO



The larger number of new radio tubes brought out each year were shown in these displays by RCA-Radiotron, Inc. and the Ken-Rad Corporation, during the Chicago convention of the Institute of Radio Engineers

+ NEW PRODUCTS

THE MANUFACTURERS OFFER

Sprayed suede finish

THE POPULARITY OF suede and suede-like materials has led to the development of a revolutionary new finish by The Zapon Company, Stamford, Conn., a subsidiary of Atlas Powder Company. It is known as Sprayed Izarine Finish. Formerly the covering of any article with suede or imitation suede meant cutting and pasting innumerable pieces and then laboriously mounting them. Now a suede-like finish can be given to any surface by merely spraying on an enamel and an Izarine powder with an air gun.

Manufacturers of a wide variety of articles, from compacts to caskets, and from toys to typewriters have shown interest in this new finish.—*Electronics, July, 1933.*

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Oscillator

VICTORY SPEAKERS, INC., 7131 East 14th St., Oakland, Calif., have introduced their Model K33 oscillator, designed by L. C. Rayment, which has direct calibration of the dial to all fundamental frequencies, thus eliminating the confusion of harmonic selection. A heavy cast-aluminum housing insures maintenance of calibration. The unit may also be used as a harmonic generator for locating short-wave bands. One scale is provided for broadcast frequencies and high intermediates, and a second scale for 150 to 350 kilocycles. The oscillator works wholly upon 60-cycle 110-volt alternating current. Price $16.80, less tube.—*Electronics, July, 1933.*

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Mercury switch, refractory protected

A NEW MERCURY SWITCH announced by the Westinghouse Lamp Company, Bloomfield, N. J., is refractory protected so as to confine the arc and to obtain long life with dependability. Made with nominal ratings from 3 amp. to 50 amp., it comprises a new line of single pole, single throw switches which may be operated in either a.c. or d.c. circuits.

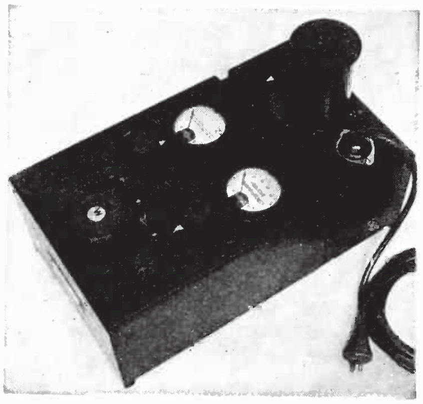
The contact in this switch is made by an impact between two pools of mercury within a refractory chamber encased in heavy glass walls. Instead of flowing slowly together, the mercury from one pool drops to meet the other with a sudden visible "jump." An atmophere of inert gas within the chamber keeps the mercury chemically pure and prevents the loss of fluidity that causes it to become gummy and slow flowing. The gas also dissipates the heat of the arc.

The 50- and 3-ampere switches are the largest and smallest in the new Westinghouse line of refractory protected switches which are single pole, single throw, and are designed for operation in either a.c. or d.c. circuits.—*Electronics, July, 1933.*

✦

Transparency meter

THE "TRANS-O-METER," a simple portable instrument for registering the transparency of flat materials directly on a dial is announced by Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. The unit is accurate, weighs only 8 pounds, operates from a 115-volt lamp socket, consumes but 200 watts, and is expected to find wide application in paper, textile, chemical, and similar industries.



In paper manufacturing, paper samples of any size or length can be used and if desired, a strip can be slowly drawn through the instrument, so that any variation in transparency can be noted. Only a few seconds time is required to determine the transparency with precision.

The density of film and plate emulsions, as well as negative contrast may be precisely evaluated. Elusive turbidity measurements can be made by using a special cup built to fit into the aperture.

The simple principle of the Trans-O-Meter consists in measuring the amount of light a 25-watt lamp will pass through the sample.—*Electronics, July, 1933.*

Photo-electric relay

IN AN IMPROVED MODEL of the DeVry "Electric Eye" the base provides space for a variable resistance unit. By merely turning the knob at the back of the base, it is easy to adjust the sensitivity for various degrees of light intensity.

The present model is made extremely sensitive to infra red rays, popularly known as "invisible rays", which makes it of special value where secrecy is required. The electric eye as described contains the transformer, photo cell, amplifier tube, and primary relay capable of carrying ½ ampere at 110 volts. A plug and 7 foot cord are included. The sockets in the base are for the relay operating contacts for closed or open circuit.

While any light source, such as flash lights, ordinary electric light bulbs, etc., may be used for operating the photo cells at short distances, operating practice utilizes a special light source with uniform illumination and lens system for making a parallel (pencil) beam of light, and the focusing mount for securing maximum illumination at varying distances.

The manufacturer is Herman A. DeVry, 1111 Center St., Chicago, Ill.—*Electronics, July, 1933.*

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"Make-your-own" adapters

WITH SO MANY NEW TUBES and circuits it is necessary to have many adapters for analyzing, tube checking, testing and experimental purposes, especially for use with out-of-date equipment. Since there are five different prong arrangements on the modern tubes, the number of adapter circuit arrangements becomes very great. To simplify the situation, the Alden Products Company of 715 Center St., Brockton, Mass., has introduced its new "Make-Your-Own" adapter parts.

In assembling the adapter, the required circuits are soldered to the convenient solder terminals of the socket section and brought down through the hollow prongs of the plug section soldering the wires to the ends of the prongs. A 6-32 screw and nut supplied with the adapter holds the socket and plug sections securely together. An important feature is the small size, making it possible for the use of these adapters in closely shielded sockets. Twin adapters or adapters with leads brought out can also be conveniently made.—*Electronics, July, 1933.*

Ring-type rheostat

The Ward Leonard Electric Company, Mount Vernon, N. Y., has developed a new ring-type rheostat for applications requiring a compact, heavy-duty unit which provides a fine, continuous adjustment.

In its construction, the resistance wire is wound toroidally around a base of refractory material and coated with Vitrohm (vitreous enamel). This construction prevents the resistance wire from shifting with adjustment of the contact shoe.

The "dead" shaft, insulated from the contact lever, makes the rheostat adaptable for mounting back of a steel panel without the use of troublesome insulating bushings or washers.

The rheostat can be furnished in values of resistance from 1 to 10,000 ohms. It will dissipate in free air 100 watts continuously with a temperature rise not exceeding 250 deg. C.—*Electronics, July, 1933.*

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16-mm. sound-on-film projector

Victor Animatograph Corporation, Davenport, Ia., announces that actual production of the new sound-on-film animatophone is under way.

Threading and operation are no more complicated than with a silent projector. The sound head, comprised of exciter lamps, lens, sound gate, photo-electric cell and threading rolls, is side-mounted on the support base of the projector and occupies a space of only $2\frac{1}{2}$ in. by $4\frac{1}{4}$ in. by 6 in. The highly developed amplifier (5 tube) is mounted at the rear of the projector and occupies a space of only 6 in. by 7 in. by 8 in. Auditorium speaker and 50′ cord are housed in a removable side of the projector carrying case. The entire equipment in carrying case weighs only fifty pounds.—*Electronics, June, 1933.*

◆

Self-generating photo-cell

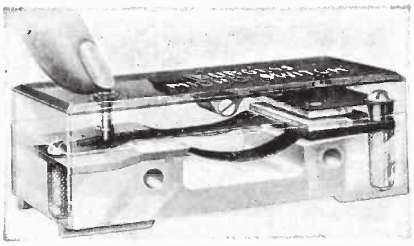
A new photoelectric cell which requires no battery or other source of voltage has recently been announced by G-M Laboratories Inc., 1735 Belmont Ave., Chicago. The new cell, designated as Visitron Type F2, is suitable for use with current indicating meters, for light-intensity measurements, or with sensitive electro-magnetic relays without vacuum-tube amplification.

The sensitive disc in the F2 cell is mounted in polished durable metal case $2\frac{1}{4}$ inches in diameter and $\frac{7}{16}$ inches thick, which is hermetically sealed. Terminal studs for electrical connections and mechanical mounting project from the rear of the cell to facilitate its use in manufactured assemblies, instruments or experimental work.

Micro switch

In Highly Compact Form, requiring only one thousandth of an inch movement and a few ounces' pressure for positive operation, there is now available a quick-acting switch capable of handling sufficient current for the majority of electrical control functions.

Contained in a neat, dust-proof, molded phenolic case, the Burgess micro switch measures $1\frac{15}{16}$ in. long, $\frac{11}{16}$ in. wide and $\frac{27}{32}$ in. high. The body is black, while a colored top serves to identify the type of switch—red top, normally closed; green top, normally open; blue top, double-throw. All types are single-pole. A tiny plunger protrudes through the top and receives the slight energy required to operate the switch mechanism. The small motion required, combined with freedom from vibration difficulties, and again the fact that this switch can be used in any position, suggests its use in many industrial, laboratory, scientific and other instruments and appliances.



The use of beryllium copper for contact springs provides freedom from fatigue or crystallization despite millions of operations; extreme speed without sticking; and ability to withstand high temperature. The switch, supplied by C. F. Burgess Laboratories, Inc., 202 East 44th St., New York City, is rated at 10 amps., 110 v. or 5 amps., 220 v., alternating current.—*Electronics, July, 1933.*

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Oil-sediment meter

The Electronic Inspection Laboratories, 1624 Hayden Ave., Cleveland, Ohio, have developed an oil-sediment meter employing a photo-cell, for quickly measuring the capacity or density of the oil in the customer's crankcase, while the car is standing at the filling station.

The portable meter contains a lamp and a photocell, the output of which is read on a graduated meter. For comparison a sample of clean oil is first daubed onto a test slide, and the transmitted light measured by the cell. Next a few drops of oil from the customer's automobile crankcase are daubed on another slide and the reading again taken, with the result that the meter pointer usually falls to the position "Poor" or "Unsafe." Such a handy meter, making tests in the customer's presence, under actual trial has resulted in selling many changes of oil. The complete oil-tester retails for $75.—*Electronics, July, 1933.*

Microphone

Audio Research, Inc., 105 East 16th St., New York City, has developed a microphone unit intended for professional use, broadcast stations, recording studios and speech-amplifier systems. It is of the dynamic type and weighs $3\frac{1}{2}$ lb. Normal speech at a distance of 2 or 3 feet will give an output of approximately minus-65 decibels. With an output of plus-12 decibels, and an amplifier gain of 108 decibels, there is thus a margin of 31 decibels to take care of unusually weak signals.

This microphone has a resistance of only 50 ohms, and operates with a uniform response between 50 and 7,000 cycles. The enclosed space above the diaphragm being small, the cavity resonance experienced on condenser microphones between 3,000 and 4,000 cycles is absent. This eliminates the shrillness found in the best condenser microphones when talking directly into them. This microphone has negligible directional characteristics, thus obviating the necessity for skillful microphone placement.—*Electronics, June, 1933.*

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Manufacturers' bulletins and catalogs

Selenium, thorium, etc.—Special metals and ores of interest to researchers and manufacturers in the electronic field, are outlined in the current issue of "Foote-prints," the house-organ of the Foote Mineral Company, Sixteenth and Summer Sts., Philadelphia, Pa. Among the materials listed are selenium, tantalum, thorium ore (monazite), tungsten carbide, zirconium, and zirconium silicate.

Insulation testing — Bulletin 1355 of James G. Biddle & Company, 1211 Arch St., Philadelphia, Pa., describes briefly five different types and forty different ranges of the Biddle Company's well-known "Megger" insulation-testing instruments, under commercial and industrial conditions. The regular testing of insulation is recommended, during manufacture, before acceptance, after installation, and periodically while in service.

Nameplates and escutcheons—In a series of new bulletins, the Crowe Nameplate & Manufacturing Company, 1749 Grace St., Chicago, Ill., describes its new products: Bulletin No. 45, Miniature wedge-drive tuning units; No. 46, Steel cabinet for baby midget receivers; and No. 47, Etched dials and nameplates for miniature receivers.

Heat controls, vacuum switches—Bulletin VS-7 of Thomas A. Edison, Inc., Orange, N. J., contains specifications for the vacuum switches, heat controls relays and other circuit devices, which are marketed by the Burling Instrument Company, 185 Market St., Newark, N. J.

Mixer and volume controls — The new General Radio Type 653 volume control, an all-purpose mixer, is described and illustrated, with application circuits, in a new specification sheet just issued by the General Radio Company, 30 State St., Cambridge, Mass.

Radio alloys—Resistance alloys and wire products in use for radio purposes, are described and specified in full detail in a new bulletin just issued by the Driver-Harris Company, Harrison, N. J. Materials covered are Ohmax. Nichrome, Radiohm, Lohm, Midohm, Gridnic, and nickel.

Noise-meter — The E. E. Free Laboratories, 175 Fifth Ave., New York City, have issued a new descriptive circular of their Type 123 Noise-meter, covering also some of the accessories and other acoustic equipment. Dr. Free reports that despite the depression, many inquiries are being received regarding this noise-meter.

U. S. PATENTS

IN THE FIELD OF ELECTRONICS

Radio Circuits

Band-pass amplifier. A superheterodyne receiver with coupling between two circuits, adjustable so that the sensitivity of each stage is automatically reduced when the selectivity is decreased. W. V. B. Roberts, RCA. No. 1,907,669.

Interstage coupling device. In a tuned r-f receiver, coupling being so designed that the system has an approximately straight line selectivity characteristic, comprising a transformer with a primary whose natural frequency is low in comparison with the mid-range frequency of the system and a feed back for improving the response to high frequencies. G. L. Beers, W. E. & M. Co. No. 1,907,478.

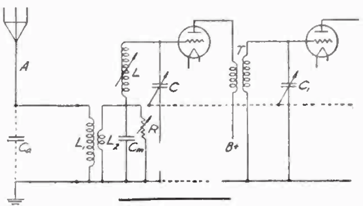
Switching system. Methods for changing a tube and circuit from a heterodyne to a radio-frequency amplifier. Lazarus Shapiro, assigned to RCA. No. 1,907,594.

Short-wave Receiver. A method of rendering the tuning of the input circuit of a short-wave receiver independent of antenna capacity changes by means of three resistances, two in series with the antenna and the high potential input coil lead, the third connected between ground and the mid point of these two resistances. The impedance of the resistors is 1,000 ohms. Herbert Muth, assigned to Telefunken. No. 1,907,653.

Detector circuit. A screen-grid detector, a method of deferring overloading in the anode circuit, comprising automatically decreasing the screen grid potential as the signal strength increases. P. O. Farnham and Raymond Asserson, assigned to RCA. No. 1,907,768.

Coupling system. A tunable high frequency coupling system. H. A. Wheeler, assigned to Hazeltine No. 1,907,916.

Input system. A series resonant circuit comprising a fixed and a variable condenser and an inductance. The input signal is impressed across the fixed condenser, and the voltage across the variable condenser is applied to the input terminals of the vacuum tube. H. A. Snow, assigned to RCA. No. 1,911,096.



Detector system. Method for deriving a steady grid biasing potential from the impressed energy comprising an impedance network solely in the input circuit, impedance common to the input and output circuit and means for preventing a-f variations of current traversing said impedance from affecting a-f variations of the potential of the grid of the tube. C. Travis, assigned to Atwater Kent. No. 1,908,381.

Cold cathode detector. Method of demodulation, using ionization in a cold cathode tube. August Hund, assigned to Wired Radio. No. 1,905,873.

Automatic volume control receiver. Combination of a carrier-wave amplifier and a screen-grid tube and means for developing direct current by diode rectifier action and for utilizing said voltage for gain control. P. O. Farnham, assigned to R. L. F. No. 1,910,099.

Piloting systems. A system for guiding mobile bodies, means for receiving energy on each side of a predetermined course with independent receiving circuits connected to each means. J. A. Willoughby, Cambridge, Mass. Filed Jan. 8, 1929. No. 1,903,846.

Crystal ejector circuit.. Method of using a quartz crystal between the intermediate frequency amplifier and the second detector in a superheterodyne to get rid of an undesired interfering carrier frequency differing slightly from the desired frequency. W. S. Barden, assigned to R.C.A. Filed Jan. 10, 1931. No. 1,904,605.

Antenna circuit. A tuned antenna circuit coupled to a receiver by a primary winding interposed between the input end of the aerial and the ground. H. A. Anderson, Brooklyn, N. Y. Filed March 10, 1930. No. 1,904,668.

Series circuit. Method of using indirectly heated cathode tubes with filaments in series, and for supplying anodes with rectified a.c. from a rectifier whose filament is in series with the amplifier tubes. A. F. P. Stenzy, Baltimore, Md. Filed Oct. 30, 1930. No. 1,904,839.

Automatic volume control. Means for rectifying a portion of the a-c energy amplified by a gain control tube and for controlling the gain of other tubes, by varying the effective anode load of the tubes according to the amplitude of the rectified current. T. A. Smith, assigned to R.C.A. Filed Oct. 29, 1929. No. 1,904,552.

Static eliminator. A resonant galvanometer with a pair of coils, one connected to an antenna through a radio-frequency amplifier and the other through a local oscillator. One of the coils is movable and carries a mirror from which light is reflected into a photoelectric cell. Variations in the collected signal energy rotates the movable coil. Joseph Bethenode, Paris, France. Filed Oct. 22, 1929. No. 1,904,607.

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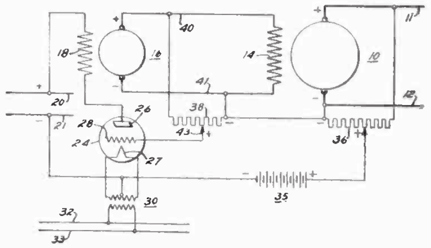
Electronic Tube Application

Inverter. System for converting d.c. to a.c., using two gaseous tubes, and a tunable oscillatory vacuum tube circuit, designed to drive the grid of the gaseous inverter tubes at the proper frequency. R. D. Fay. Assigned to Submarine Signal Corp. No. 1,906,558.

Electric piano. A musical instrument, comprising several sources of oscillation from the same fundamental frequency and of different harmonic composition; means for altering the relative phases of said oscillations; and for converting said oscillations into sound. C. T. Jacobs. Assigned to Meissner Inventions, Inc., No. 1,906,607.

Noise analysis. Apparatus for investigating noises and other mechanical vibrations associated with running machinery, comprising an amplifier and apparatus to give a visual indication of the oscillation. R. E. H. Carpenter and R. Fansteel, England, No. 1,907,415.

Generator control. Method of using an electron tube for controlling the excitation of a dynamo electric machine. F. H. Gulliksen, assigned to W. E. & M. Co. No. 1,909,104.

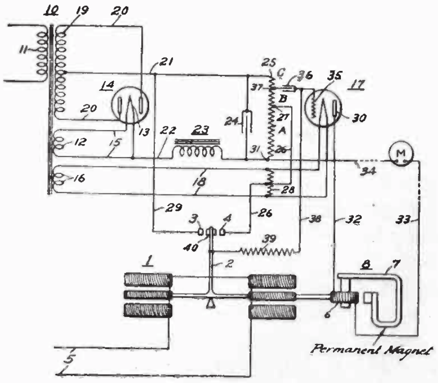


Polyphase generator. Method of producing a.c. by shining a light through holes in the periphery of a rotating disk onto a 3-cathode photo-sensitive surface. C. W. Hough, assigned to Wired Radio. No. 1,912,139.

Electrical musical instruments. Method of translating electric oscillations into audible tones. B. F. Miessner, assigned to Miessner Inventions, Inc. No. 1,912,293.

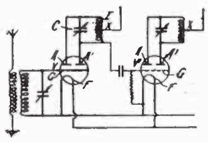
Stress measuring. Method of using piezo-electric apparatus for measuring stress of an object. A. M. Nicolson, assigned to Wired Radio, Inc. No. 1,912,213.

Remote indicating system. System for measuring a quantity, an energy storage device and a means using a vacuum tube for indicating the quantity of energy stored. B. E. Lenehan, assigned to W. E. & M. Co. No. 1,911,372.



Tube relay system. A maximum and minimum limit device employing vacuum tubes and their necessary relays. W. Van Benschoten, Fishkill, N. Y. No. 1,911,656.

Multi-element tube. A tube with a nickel filament, a control electrode, a plate electrode and several additional elements of similar physical character to the electrodes and disposed substantially outside the cathode field, the filament element being symmetrically disposed with the respect to the valve electrodes and the additional elements. James Robinson, London, England. No. 1,908.920.



Automatic steering device. Electron tube system for automatically steering sea-craft and aircraft. N. Minorsky, assigned to Pioneer Instrument Co., No. 1,912,489.

Altimeter. Method of determining the altitude of aircraft above the earth by radiating a high frequency wave from the craft; causing the frequency to vary cyclically as the craft varies in altitude. E. F. W. Alexanderson, assigned to G. E. Co. No. 1,913,148.

Modulating system. Method of modulating a photo-electric cell by means of a cathode ray tube. Fritz Schroeter, assigned to Telefunken. No. 1,912,732.

Electric organ. Vacuum tube organ containing means for producing notes which form harmonic or other notes, produced simultaneously, to change the timbre. E. E. Coupleux and J. A. M. Givelet, Paris, France. No. 1,905,996.

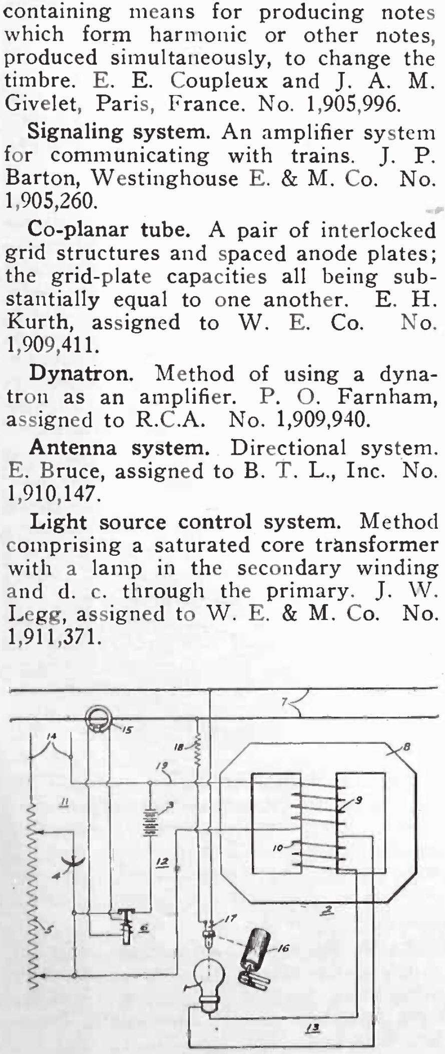
Signaling system. An amplifier system for communicating with trains. J. P. Barton, Westinghouse E. & M. Co. No. 1,905,260.

Co-planar tube. A pair of interlocked grid structures and spaced anode plates; the grid-plate capacities all being substantially equal to one another. E. H. Kurth, assigned to W. E. Co. No. 1,909,411.

Dynatron. Method of using a dynatron as an amplifier. P. O. Farnham, assigned to R.C.A. No. 1,909,940.

Antenna system. Directional system. E. Bruce, assigned to B. T. L., Inc. No. 1,910,147.

Light source control system. Method comprising a saturated core transformer with a lamp in the secondary winding and d. c. through the primary. J. W. Legg, assigned to W. E. & M. Co. No. 1,911,371.



Condenser tester. Means for repeatedly and rapidly charging a condenser and means for reading the charging current and the discharge current. C. J. Assigned to Joseph Weidenhoss, Inc., No. 1,906,466.

Timing arrangement. A condenser and resistance connected with a gaseous discharge device and a relay. K. H. Blomberg. Assigned to L. M. Ericsson, No. 1,907,279.

Photometric instrument. In combination with a light source a ratio indicating instrument having elements responsive to the quantity of light emitted by the source and the energy consumed thereby. F. C. Hoare. Assigned to G. E. Company, No. 1,906,597.

Light control system. Apparatus for detecting the variation in properties of fluid by measuring the variation of the optical properties, including a photo sensitive means. C. A. Styer, assigned Assigned to Westinghouse E. & M. Co. 1,905,251.

Tube voltmeter. A push-pull voltmeter with the indicating meter in the common plate lead and means for compensating differences in amplification constants of the two tubes. J. D. Booth. Assigned to Westinghouse S. & M. Co. No. 1,907,487.

Direct reading meter. Method of reading directly ohms and capacities by means of a vacuum tube oscillator. P. S. Edwards and C. D. Barbulesco. Nos. 1,905,348, 1,905,349 and 1,905,332.

System of control.—Method for controlling the motion of an object movable in a constrained path using vacuum tubes. R. B. Taylor, assigned to G. E. Co. No. 1,910,190.

Voltage regulator. Method of controlling the voltage of a d-c generator by means of vacuum tubes by impressing upon these tubes a potential determined by the difference in the generator voltage from a desired value. F. H. Gulliksen, assigned to W. E. & M. Co., No. 1,909,054.

Frequency meter calibration. A stroboscopic method of calibrating frequency meters using light sensitive cell. E. H. Greibach, assigned to W. E. & M. Co. No. 1,909,103.

A capacity controlled relay. Automatic control for photographing exposures. A light sensitive means for varying the light falling on a film in the printing process. L. A. Jones and C. M. Tuttle. Assigned to Eastman Kodak Co. No. 1,908,610.

Television system. Method for synchronizing the speed of a rotating armature with received signals by a circuit with an element which passes no current for less than a minimum applied voltage and a means for periodically reducing the voltage supplied below said minimum. H. C. Donle, assigned to Radio Inventions. Filed Sept. 17, 1928. No. 1,903,986.

Amplifier. Push-pull amplifier of four tubes, two on each side of the circuit with the grids and plates parallel but with the filaments in series. J. L. Reynolds, assigned to E.R.P.I. Filed Dec. 31, 1929. No. 1,904,533.

Lamp testing. Apparatus for testing incandescent lamps composed of an evacuated or gas-filled enclosure. A receptacle into which the device may be inserted and a high frequency electrical discharge circuit with current indicating means actuated by the current flowing in the circuit while the device is being subjected to the discharge. W. L. Kubach, assigned to G. E. Co. No. 1,904,059.

Stroboscope. A source of supply of d.c., a reactor and a capacitor in series, and connected with said source, a vapor electric discharge device to be energized from the capacitor and provided with a control grid and means for controlling the charge on the grid. W. D. Cockrell, assigned to G. E. Co. Filed Aug. 27, 1932. No. 1,904,124.

Control system. An a-c load circuit and control means for the circuit comprising electric valve apparatus provided with a control grid and a means for supplying a variable d-c control voltage to the grid. O. W. Livingston, assigned to G. E. Co. Filed Sept. 11, 1931. No. $1,904,485.

Amplifiers, Etc.

Push-pull amplifier. A two-stage cascade amplifier, a pair of transformers in the first stage having their primary winding connected in reverse parallel and a secondary winding in series. F. Thorington, Birmingham, Ala. Filed Nov. 15, 1929. No. 1,904,103.

Low frequency amplifier. Interstage coupling circuit composed of a transformer with a low ratio of transformation selected to approximately match the plate circuit impedance of the preceding tube with the grid circuit of a succeeding tube, when the grid thereof swings considerably positive whereby the introduction of distortion due to the flow of grid current in said amplifier is minimized. H. A. Wheeler, assigned to Hazeltine Corp. Filed Feb. 17, 1927. No. 1,904,185.

Interstage device. Circuit for connecting the output of a tube to the input of the following tube. K. Posthumus, assigned to R.C.A. No. 1,904,524.

Patent Suits

1,195,632, W. C. White, Circuit connections of electron discharge apparatus; 1,251,377, A. W. Hull, Method of and means for obtaining constant direct current potentials; 1,728,879, Rice & Kellogg; Amplifying system; Re. 18,579, Ballantine & Hull, Demodulator and method of demodulation; 1,811,095, H. J. Round, Thermionic amplifier and detector, filed Apr. 24, 1933, D. C., S. D. N. Y., Doc. E 75/346, Radio Corp, of America et al. v. Radio Syndicate, Inc.

1,231,764 (a), F. Lowenstein, Telephone relay; 1,618,017 same, Wireless telegraph apparatus; 1,465,332, H. D. Arnold, Vacuum tube amplifier; 1,573,374, P. A. Chamberlain. Radio condenser, filed Apr. 24, 1933, D. C., S. D. N. Y., Doc. E 75/345, Radio Corp. of America et al. v. Radio Syndicate, Inc.

1,231,764 (b), F. Lowenstein, Telephone relay; 1,618.017, same, Wireless telegraph apparatus; 1,403,475, H. D. Arnold, Vacuum tube circuit; 1,465,332, same, Vacuum tube amplifier, D. C., So. D. N. Y., Doc. E. 74/456, Radio Corp. of America et al. v. H. F. Lyman (Lyman Mfg. Co.) et al. Consent decree for plaintiff (notice Apr. 27, 1933).

BRITISH PATENTS
IN THE FIELD OF ELECTRONICS

Electronics Application

Deafness tester. Apparatus for testing and treating deafness comprising a valve generator having means to vary the frequency throughout a wide range without change of volume and means for widely varying the volume without changing the frequency. O. E. Marvel, Grand Rapids, Mich. No. 388,594.

Gaseous tube circuits. Vapor electric device rendered fully conducting by applying a high frequency potential to the grid circuit and non-conducting when a variable negative grid bias exceeds the amplitude of the high-frequency potential. The invention is applied in a system for alternately dimming and brightening simultaneously the lamps in two different circuits. B. D. Bedford, British Thomson-Houston Co. No. 388,809.

Constant frequency generator. Grid controlled rectifiers utilized to maintain the vibration of a tuning fork and arranged in push-pull so that starting the discharge in one tube stops the discharge in the other. G. E. Co., Ltd. No. 388,904.

Photo-electric engraving system. Process and apparatus for producing engraved surfaces with the aid of a mechanical cutter, the depth of cut regulated by coils energized by variations in the amount of light reflected in accordance with the variations in tone from the original onto the photo-electric cell. In this circuit, grid-controlled rectifiers are used to drive the cutting tool. J. W. Dalton, 16 Abbott Ave., Wimbledon, London. No. 389,102.

✦

Radio Circuits

Detection circuits. Method of overcoming the defect of a square law detector which accentuates the difference between loud and soft passages of the program. One method is by amplifying weak signals more strongly than loud signals. L. Pungs, Brunswick, Germany. No. 387,182.

Short-wave generator. Method of generating oscillations of the order of a few centimeters in length by a special structure tube. C. W. Rice, assigned to British Thomson-Houston Co. No. 387,697.

Low frequency amplifier. A resistance capacity coupled amplifier with an inductance in series with the coupling condenser to increase the relative amplification of the higher frequencies and a condenser in parallel with the inductance to tune it to the frequency at which a cut-off is desired, for example 9,000 cycles. Siemens & Halske, Berlin. No. 387,912.

Frequency changer. Method of adapting a receiving set for reception of wave lengths outside its tuning range by interposing between the antenna and the receiver a frequency changing device. I. Diaz, Neuilly, France. No. 388,235.

Frequency generator. A crystal control generator coupled to a second generator so as to maintain the frequency of the second at a figure which is an integral fraction of the former. The lower frequency modulates the higher frequency. F. J. Moles, assigned to British Thomson-Houston Co. No. 388,014.

Noise suppressor. Method of utilizing the r-f component in the AVC system to control the a-f amplifier so that this is inoperative in the absence of a signal. T. B. Morehouse, Marconi Co. No. 388,601.

Intermediate frequency coupling device. One coil, preferably the primary of an inter-stage transformer is tuned by a condenser to the intermediate frequency and the other coil so wound as to be resonant at a frequency higher than the intermediate frequency but lower than the lowest signal frequency to which a receiver can be tuned. The transformer as a whole resonates at the intermediate frequency. The secondary coil acts as capacity at all frequencies within the tuning range and attenuates signals which penetrate the first detector without change of frequency. W. A. MacDonald, Hazeltine Corp. No. 389,026.

Plate current reducer. The grid bias of a valve amplifier varies with the signal volume, the bias becoming so much more negative as the volume diminishes that the sum of the bias and the signal voltage is practically constant. In this way the consumption of plate current is reduced and the efficiency increased. Philips, Holland. No. 388,292.

FIG. 1.

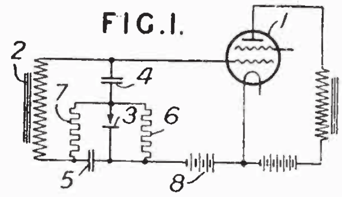
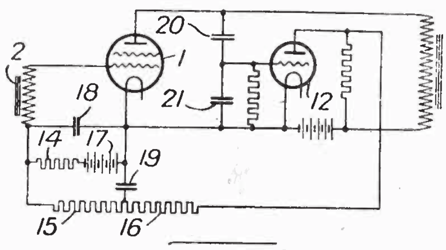


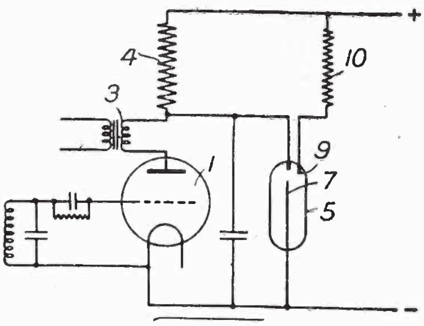
FIG. 2.



Aircraft radio. Method of compensating for disturbances picked up by the aerial and due to the engine ignition system. To the input of the receiver components of correct amplitude and phase obtained from the disturbing source are applied by means of an auxiliary linear aerial. H. H. Beverage, Marconi Co. No. 384,470.

Battery eliminator. In a device to operate on d. c. or a. c., a choke is provided which functions as a smoothing choke during d. c. operation and as a transformer during a. c. operation. A. E. G., Berlin. No. 388,313.

Visual tuning device. Visual indication of the signal strength in a receiver is obtained from a glow discharge tube connected between the junctions of the detector anode impedance and the output transformer and the cathode circuit. G. E. Co., Ltd. No. 388,516.



Amplification, Generation, Etc.

Relaxation oscillators. Two generators, each comprising a neon tube in parallel with a condenser and supplied from a d.c. source through a resistance are interconnected by means of an electro-magnet, so that the ratio of frequency of the two circuits is maintained constant. Papeteries Navarre, Lyons, France. No. 386,327.

Distortion compensation. Frequency distortion in a photocell feeding an amplifier is counteracted by a frequency discriminating arrangement for television purposes. H. E. Ives assigned to ERPI. No. 386,296.

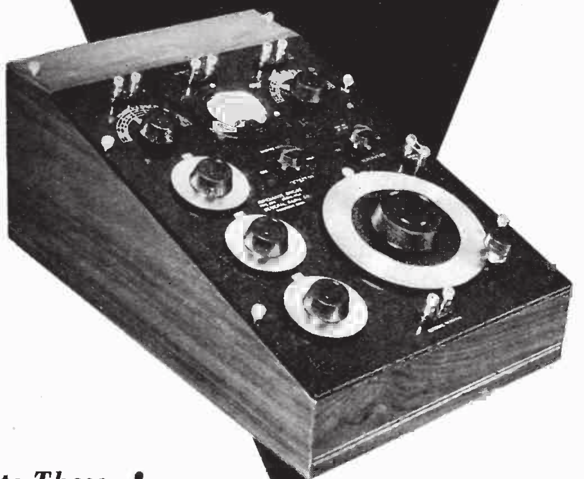
Modulation system. Use of a gaseous or vapor tube as a variable capacitance in a high-frequency signal transmission system in which a sheath of positive ions is attracted by a negative charge on an electrode. The thickness of the sheath, and so the capacitance, is controlled in accordance with the signals and varying the frequency of the oscillation transmitters. I. Langmuir assigned to British Thomson, Houston Co. No. 386,356.

Recording system. A gas-filled cell for use in reproducing photographic sound records has electrodes formed or arranged so that a highly non-uniform field of great density is produced at the anode together with an unstable ionization which raises the power of the cell and is completely controllable by variations of light with the highest potentials below the spark potential, without permitting a disturbing glow discharge. The cell may be used without a voltage amplifier. W. Barsties, Berlin. No. 386,369.

Code system. Single-current signals such as audio-frequency signals are converted into double-current signals by means of a tube so arranged that spacing the current is cut off as soon as marking current is received. Siemens Bros. & Co. No. 386,743.

Ac-Dc Receiver. An arrangement for radio set operation from either direct or alternating current by means of change over switches. C. P. Stanworth, Burnley, England. No. 386,776.

Measure C, R, L, and Power Factor on This New Bridge



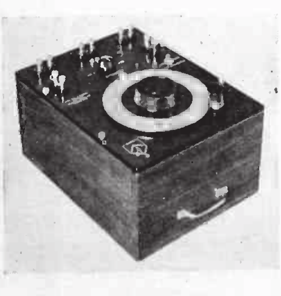
Note These Wide Ranges!

Capacitance: 8μμf to 100μf
Resistance. 0.01Ω to 1MΩ
Inductance: 5μh to 100h

THIS new bridge furnishes a ready means for measuring the capacitance, resistance, and inductance of circuit elements and of determining in a single operation, the power factor of the condenser and the "Q" of inductors. Except for the necessary head telephone used for the a-c measurements, the instrument is entirely self-contained.

The extremely wide range of values that this bridge can cover makes it of tremendous importance to the experimental laboratory where the need for measuring anything that may come up with good accuracy is of importance. For the first time an all-purpose bridge is commercially available at a reasonable price.

The Type 650-A Impedance Bridge is priced at $175.00.



A new skeleton-type bridge is also available for laboratories where the wide range of the Type 650-A Impedance Bridge is unnecessary. The Type 625-A Bridge, with additional plug-in condensers and resistors, will be found useful for building up limit bridges and other special purpose instruments. *Price: $65.00 without accessories.*

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Write for descriptive literature on these two new bridges. Ask for Bulletin EX-3304 and address the General Radio Company, 30 State Street, Cambridge, Massachusetts.

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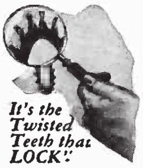
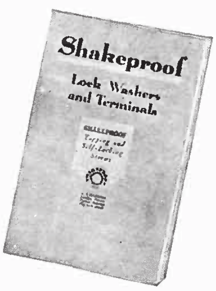


It's the Twisted Teeth that LOCK



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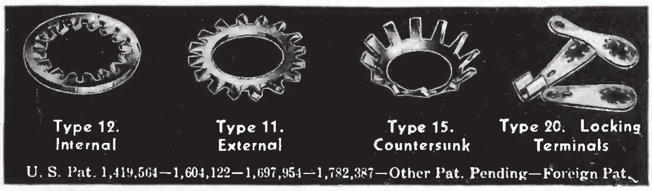


U. S. Pat. 1,419,564—1,604,122—1,697,954—1,782,387—Other Pat. Pending—Foreign Pat.

BOOKS ON ELECTRONIC SUBJECTS

Einführung in die Elektronik

(Introduction to Electronics); Otto Klemperer; Verlag von Julius Springer, Berlin: 1933; Paper covers: 18.60 marks ($4.50); bound: 19.80 marks ($4.75)

DR. KLEMPERER HAS COMPILED in this comprehensive work an account of the experimental literature bearing upon the electron, its properties and behavior, with emphasis on the developments of the post-war period. The book is dated March, 1933, and covers the literature to the end of 1932.

The book is divided into three main headings: (1) The Free Electron; (2) Electron Emission; (3) Interaction between Free Electrons and Atoms.

The first section opens with methods of accelerating electrons, and the theory of the variation of mass with velocity. The mathematical expressions for the paths under the influence of electric or magnetic fields, or combinations of the same are given, and the experimental apparatus for velocity analysis outlined. Of especial interest are the so-called "electric lenses" and "magnetic lenses," which permit a tremendous concentration of the electron beam traversing them. The various methods for showing the action of free electrons are then taken up: viz., ionization chamber, anode heating, fog-tracks, B-ray scintillations, and traces on photographic plates. A section is devoted to the determination of the charge and mass of the electron. The fundamentals of the wave-mechanics theory are briefly stated, and application of the Fermi Statistics made to the electron gas in the interior of a metal.

The second main section deals with electron emission. Some criticism may be directed at the portion devoted to thermionic emission on account of its somewhat sketchy and non-critical character. The part dealing with photo-electric phenomena is more complete, although here also there is evidence that the author is relying upon other compendia. Professor DuBridge's large and excellent treatise fails to receive mention.

The final section deals with the interaction between electrons and atoms. The difficulties of applying the Schrödinger wave equation to any but the simplest cases is pointed out, and some of the results of approximate solutions of the problem of charge distribution in the atom are given. Scattering of electrons by the fields of the atoms and molecules they pass is described. Electron diffraction experiments receive considerable attention. The latter subdivisions deal with the experimental work on excitation and ionization voltages, electron absorpton, and the newer concepts of "free wavelegth" and "electron diffusion."

Dr. Klemperer is to be thanked for the lucid style and clear language used. The book is plentifully supplied with line drawings, and there are some beautiful experimental photographs.

An investigation of high-selectivity receiving circuits

By F. M. Colebrook. (Special Report No. 12, of the Radio Research Board) 69 p. with 22 diagrams. H. M. Stationery Office, London, Price 1s. 3d.

THE REPORT DISPOSES of the hope that the adoption of receivers with extremely selective tuning and tone-correction in the audiofrequency stages would permit the use of a larger number of stations within a given frequency band. It was found that the combination of high selectivity and tone correction merely reduces cross-talk, but is not insensitive to the interference between the wanted carrier and the carrier or side-waves of the interfering station (audible or inaudible beat). One half of the report is devoted to a theoretical, the other half to the experimental study of the problem (Transient conditions are not taken into account although the inventor of the circuits insisted at the time on the part they play, and the answer may therefore not be as definite as might be desired. The report attributes these effects to asymmetry in the resonance curve). The quartz crystal is found to have an inherently asymmetrical resonance curve even when a balanced bridge connection is used, resulting in harmonic distortion and non-uniform response to the modulation frequencies.

Thyratron control of welding in tube manufacture

[*Continued from page 187*]

T_1. The bias is reduced by commutation of T_2 to the voltage drop across resistor R_7 instead of to zero, and the peaked a-c grid voltage from peaking transformer Tr_3 is of sufficient magnitude to overcome the reduced bias and fire T_1. Curve D of Fig. 3 illustrates this type of grid excitation in the "firing" position. Shifting the phase of the grid transformer primary voltage by varying R_1 shifts the position of the peak, in this way controlling the length of the conducting period.

Examples of the performance are shown in Fig 4 and Fig. 5. Fig. 4 (left) shows an extreme case of the bad discoloration using manual control on an experimental assembly as compared to the same assembly (right) made with a half-cycle Thyratron control welder. Examples of various welds are given in Fig. 5. These welds were made with little difficulty, the only requirements being sufficient current for fusion and ample pressure to prevent sparking at the high current densities. The welding current ran as high as 6000 amperes peak for some of these welds.

A panel capable of delivering 75 amperes peak current to the primary of a welder transformer has been in operation at R.C.A. Radiotron Company. A panel of this current capacity operating from a 220 volt a-c source has sufficient kva capacity to meet most of the requirements of receiving tube manufacturers.

One of these panels, in conjunction with a suitable distributor, would supply up to ten one-half cycle spot welders and each welder have a maximum delay of only one-half second between closing the control switch and making the weld. Each welder would have a series resistor or taps on the transformer to regulate the current to the best value for the operation performed on that particular welder.

For many types of work the results obtained by the control described are so far superior to that obtainable with mechanical control that this system should have a wide field of application. The initial cost, although higher than most of the usual types of control, is warranted because of the superiority of the results obtained.

electronics

radio, sound, communications and industrial applications
of electron tubes • • • design, engineering, manufacture

Cost versus quality in radio parts

◆

New tubes for ultra-short waves
(See page 214)

◆

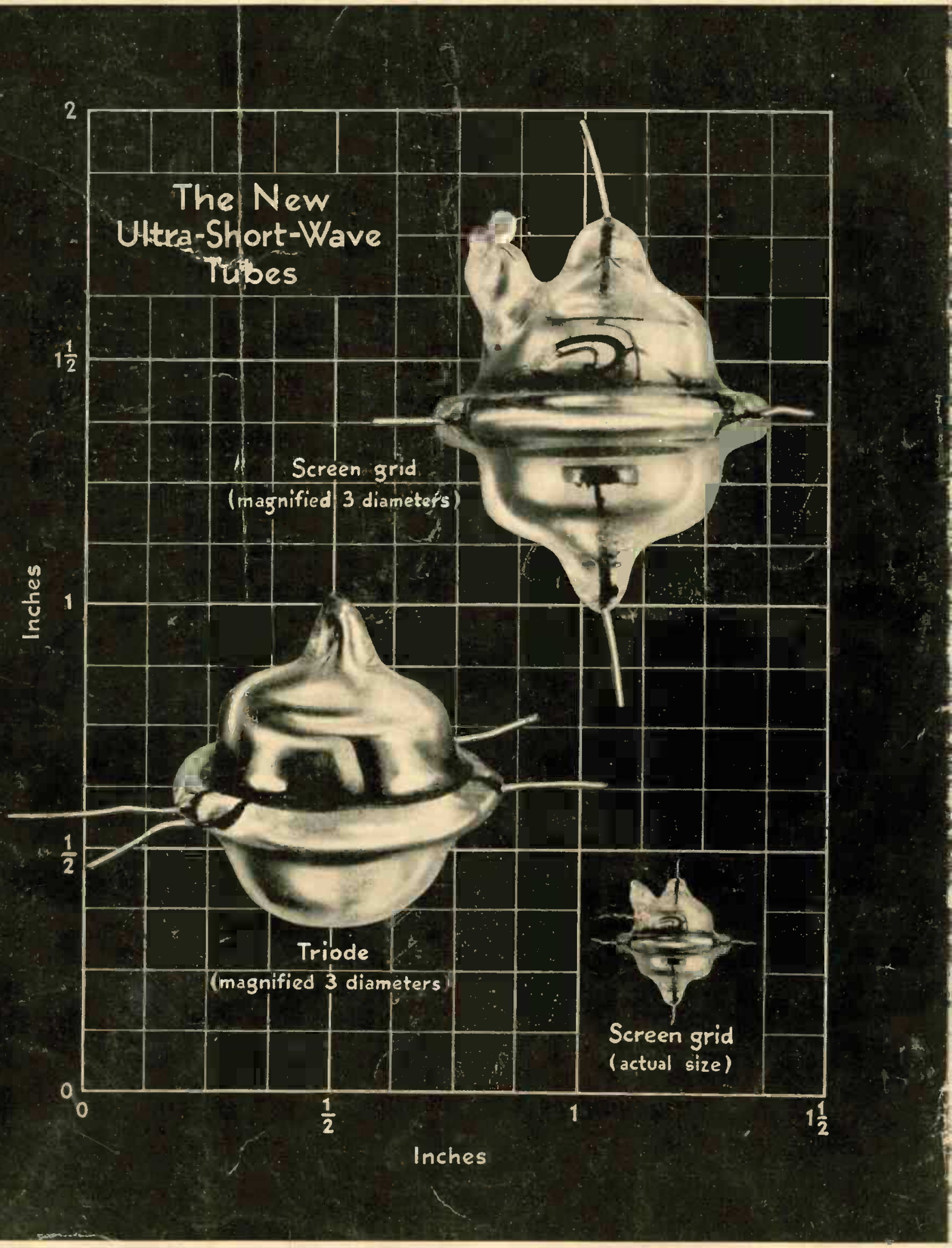
The Radio Industry Code

◆

Outdoor movie theaters

◆

New high-speed electron guns


The New Ultra-Short-Wave Tubes
Screen grid (magnified 3 diameters)
Triode (magnified 3 diameters)
Screen grid (actual size)
Inches
2
1½
1
½
0
0
½
1
1½
Inches

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Electronics, August, 1933. Vol. 6 No. 8. Published monthly. McGraw-Hill Publishing Company, Inc., 330 West 42d Street, New York, N. Y. $3.00 per year. 35 cents a copy. Foreign postage, $4 U. S. Currency or 20 shillings. Canada (including Canadian duty), $3.50. Entered as second-class matter April 4, 1930, at the Post Office at New York, N. Y., under the Act of March 3, 1879.

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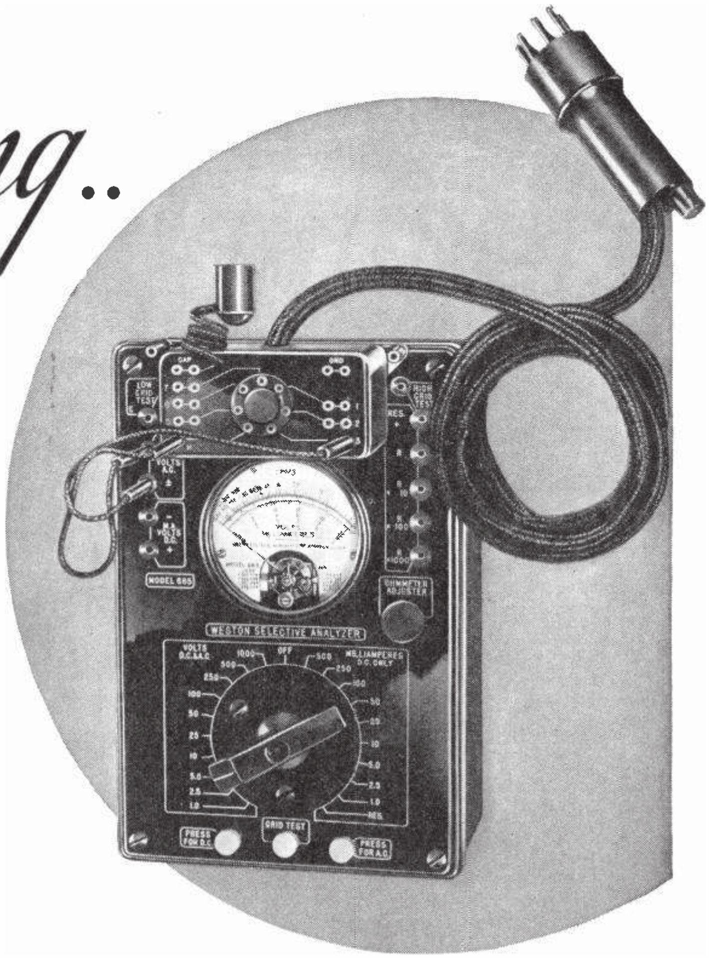

No longer is there the slightest need for worrying about Analyzer obsolescence. Weston has found the solution, providing a design which is always up-to-date regardless of tube developments. It's a method of Selective Analysis involving the new Weston Model 665 Selective Analyzer and suitable Tube Selectors.

Weston Model 665 Selective Analyzer contains all the necessary voltage, current and resistance ranges. Tube Selectors to accommodate 4, 5, 6 and 7 prong tubes are provided. You merely attach the proper Tube Selector to the Selective Analyzer. Next insert the plug into the tube socket of the radio set. Then by plugging into the proper jacks, voltage, current and resistance may be read in any part of the entire network leading to the tube socket.

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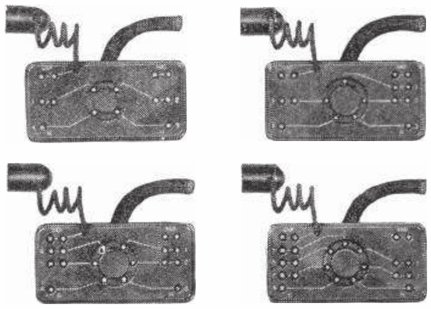

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Please send bulletin describing Model 665 Selective Analyzer and Tube Selectors.

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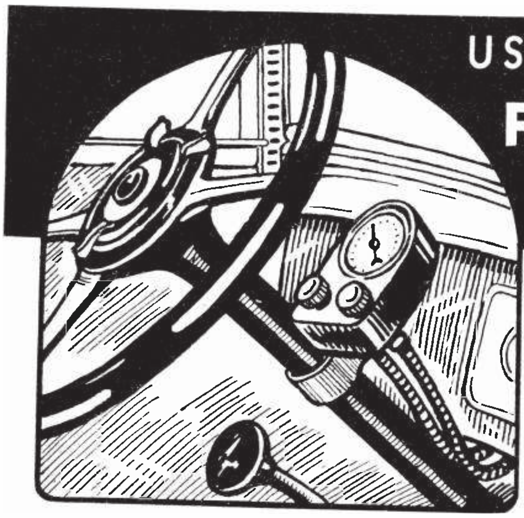

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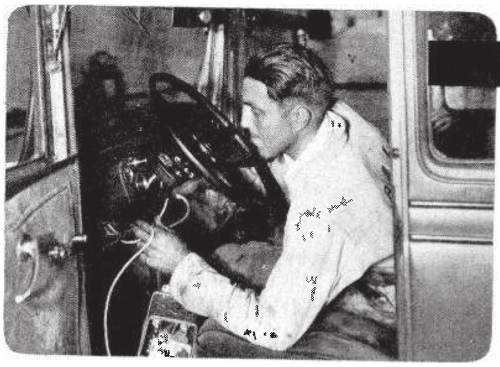
Better for you, the SET MAKER

because: flexible shaft remote control simplifies the design and improves the performance of your set. It provides not only accurate and simple tuning control, but also remote control of volume and switch, permitting location of volume control in the set proper—the most desirable position in the circuit.



Better for your DEALERS

because: the flexible shaft controlled set can be easily installed in any car, giving wide latitude for locating receiver in the position that will avoid electrical, structural and physical interference, with control always convenient to driver. Control "stays put" and does not eat up profits in servicing.

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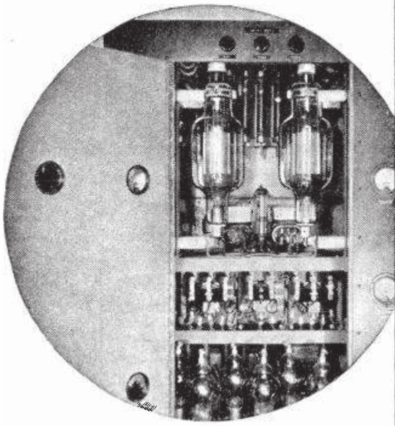
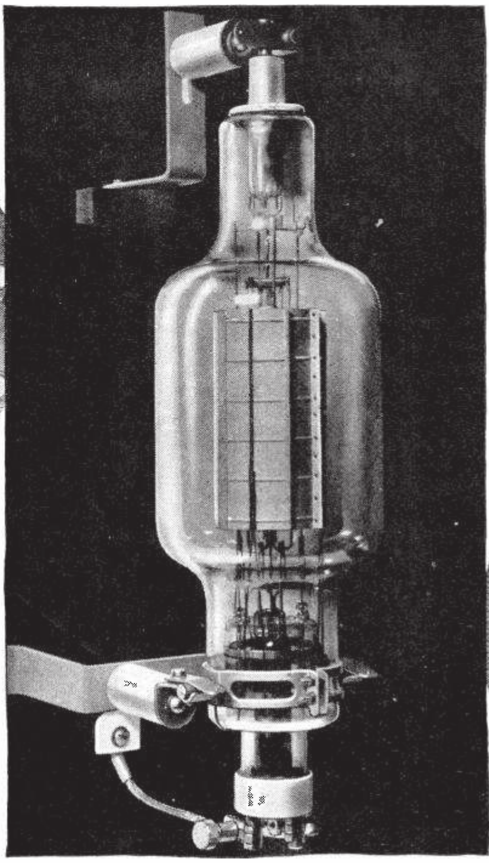
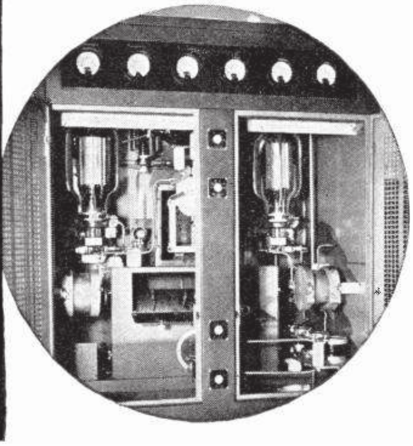


Typical mounting of two Western Electric 279A tubes in a radio telephone transmitter.



Two Western Electric 279A tubes mounted in the Western Electric 305A transmitter used by the police of the City of New York.



In a class of its own ... the Western Electric 279A

Developed for service in the new Western Electric radio transmitters using only radiation-cooled tubes, the 279A has the highest rating of any tube of this type. ℭ The anode with its 9 radiating fins has been designed to give maximum energy radiation. The thoriated tungsten filament assures adequate electron emission for full, efficient usage of the tube's energy capabilities. Mounting of the 279A's elements provides high insulation in a rugged structure — while terminal arrangements make for ease of mounting and replacement. ℭ A Western Electric product — long life and uniform characteristics are assured.

Western Electric 279A Tube

A general purpose tube having the following characteristics:

Filament Voltage	10
Filament Current, Amperes	21
Average Plate Resistance, Ohms	1800
Average Mutual Conductance, Micromhos	5550
Amplification Factor	10
Approximate Direct Interelectrode Capacities	
Plate to Grid	18 Mmf.
Plate to Filament	8 Mmf.
Grid to Filament	15 Mmf.
Maximum Plate Voltage	3000
Maximum Plate Current, Amperes	800
Maximum Plate Dissipation, Watts	1200
Maximum Overall Length	21 11/16"
Maximum Diameter	6"

Western Electric

RADIO TELEPHONE BROADCASTING EQUIPMENT

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Mallory-Elkon Dry Electrolytic Condensers are available in whatever form best suits the requirements of the Set Designing Engineer: rectangular cardboard container types with or without mounting flanges, of the shape most suitable for the application involved; tubular cardboard containers, for use where this shape proves most suitable; rectangular metal cans — round metal cans, either for upright or inverted mountings with either lugs or insulated lead connections. In no other type condenser has the Designing Engineer so much flexibility as to shape, mounting facility or types of connections.

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SERVING THE GREAT
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Condensers
Volume Controls
Selector Switches
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MALLORY ELKON YAXLEY

electronics

O. H. CALDWELL
Editor
KEITH HENNEY
Associate Editor

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NRA
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Vol. 6, No. 8. New York, August, 1933

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telegraphy
counting
grading
carrier systems
beam transmission
photo cells
facsimile
electric recording
amplifiers
phonographs
measurements
receivers
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traffic control
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THE RADIO CODE

THE "Code of Fair Competition for the Radio Industry," drawn up and submitted by the Radio Manufacturers Association, is a carefully composed document and should serve as an effective influence for stabilizing the radio business and creating more jobs—which latter is the primary purpose of the NIRA administration.

All in all, the Code work was well done, under most difficult conditions of pressure, trade cross-currents and counter-proposals, and summer heat. Its text, as submitted, is summarized on a following page.

But engineers will detect several points of injustice in the Radio Code. Engineers, for example, are excluded from the limiting hours of labor. As intellectual workers, engineers might take pride in this distinction, were it not for certain manufacturers who drive their engineers to continuous overtime at starvation wages and then drop them without notice.

The clause specifying that no new radio tubes shall be introduced for the next year has a certain justification, as things stand in radio today; but any such principle of technical "stand-still" is unsound, and its extension will prove ultimately destructive. Another novel economic principle offered in the tube chapter provides that sales below cost of production, if made to meet competition, are not to be regarded as selling below cost!

MANY radio manufacturers are still in a quandary whether the NRA labor requirements are to prove a blessing or a curse to their own businesses. But there can be no doubt that industry as a whole will benefit, and that with national recovery radio sales will grow.

A summary of the provisions of the

NRA Radio Industry Code

THE radio industry will henceforth have its control centered in a Radio Emergency National Committee, made up of the executive committee and division chairmen of the Radio Manufacturers Association. The "code of fair competition" as submitted to the National Recovery Administration on July 29, further provides six divisions of the radio manufacturing industry, for purposes of administration:

1. Radio Receiving and Television Set Division.
2. Radio Tube Division.
3. Radio Parts, Cabinets, and Accessories Division.
4. Radio Loud Speaker Division.
5. Sound Distribution Equipment Division.
6. Fixed Condenser Division.

Other divisions may later be established, upon approval of the National Committee and the executive committees of the existing divisions.

At the outset of the Radio Industry Code, it is expressly stated that their Code shall not be used, interpreted or applied in such a manner as to permit or promote monopolies or monopolistic practices, nor to eliminate or oppress small enterprises, or operate to discriminate against small enterprises.

Provisions for employment

Conditions of employment have a prominent position in the Code. Employees have the right to organize and bargain collectively, and to be free from restraint or coercion by employers, nor are employees to be required to join any company union nor to refrain from joining or assisting labor organizations of their own choosing.

In radio factories, no one under 16 years of age shall be employed. The minimum wage of factory or processing employees shall be 40 cents per hour, unless the rate was less on July 15, 1929, but in no event shall any rate less than 30 cents per hour be paid. Casuals and incidental labor and learners, not to exceed 5 per cent of the factory payroll, may receive 80 per cent of the regular rate. Such factory and processing employees shall not work more than 36 hours per week.

For other employees, office workers, etc., but not including commission salesmen, the minimum rate of pay is to be $15 per week, although office boys and girls and learners, may receive 80 per cent of the regular scale.

For all such other employees, except executive, administrative, research, engineering, and supervising employees, and traveling and commission salesmen, the hours of work shall not exceed 40 hours per week. It is provided, however, that where seasonal or peak demand requires an unusual or temporary burden of work, the schedule may be extended but each such case must be reported fully to the Federal Administrator, through the National Committee.

Section 6 of the main Code further provides that no manufacturer shall sell or offer for sale any radio products which have been made by employees receiving less than the standard minimum wage or working more than the standard maximum hours, or by employees under 16 years of age—except products already in process of manufacture prior to the date the Code becomes effective.

No sales below cost of production

Section 7 provides that in order to meet such labor and payment conditions, no manufacturer shall sell his products for less than a sum sufficient to compensate him therefor—that is, he shall not sell for less than the cost of production. Such cost of production is defined by the Code as embracing the costs of selling, advertising and administration and all other expenses of every kind and character which the manufacturer shall incur in the operation of his business, unless excluded by the Code.

Section 8 authorizes each manufacturer to add to the cost of production, as so defined, such amounts or percentages as he may deem advisable to constitute the net prices or list prices of his products, which prices shall be national and applicable whether sold within the state where manufactured, or in interstate commerce. In determining such price, however, no manufacturer shall discriminate between his various types of radio products in allocating overhead for production, selling, advertising, and administration. No method of price discrimination between customers shall be employed.

The Radio Emergency National Committee is defined as the general planning and co-ordinating agency for the radio industry. It is empowered to act for the divisions, call for reports from divisions, investigate infractions of the Code, and enforce provisions of the Code, and its decisions become conclusive on all manufacturers under the Code.

The National Committee is to adopt a standard uniform cost-accounting system, select public accountants, and require from all members of the industry information as to factory capacity; production, orders and shipments during the month; inventory of finished merchandise on hand; number of persons employed, wages, earnings and hours; and net or list prices in effect at the time reported.

The National Committee is also empowered to act as a tribunal to reach adjustments, in cases where the costs of completing contracts entered into prior to the enactment of the Code, are increased by the provisions of the Industrial Recovery Act.

Set, tube and other chapters

Supplementary chapters to the Code relate to the special conditions surrounding each division. The first chapter relating to receiving and television sets presents detailed classification of products by lines, and by numbers of tubes, as the basis of analysis and cost study

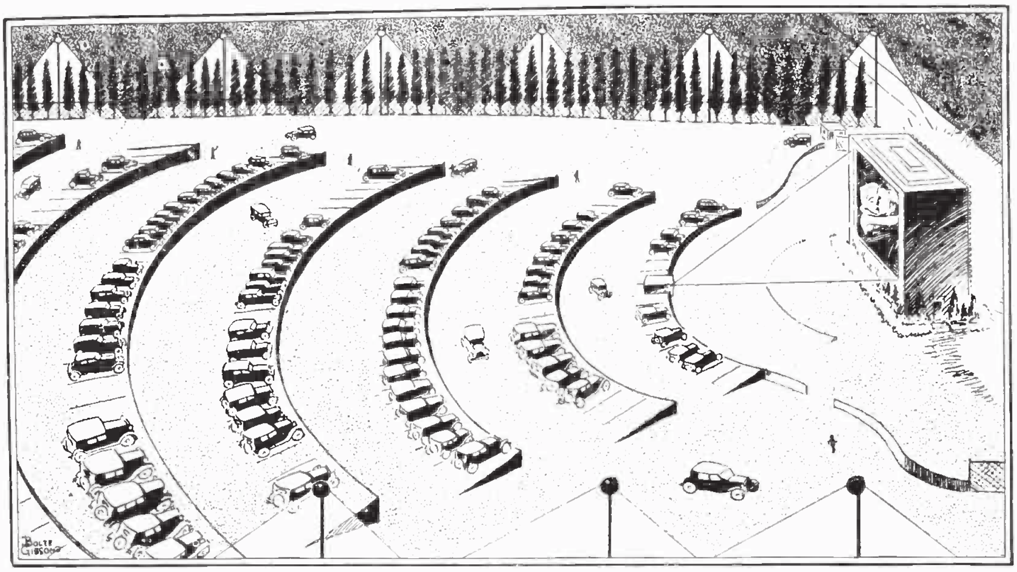
[Please turn to page 230]

THE "DRIVE-IN" MOVIE

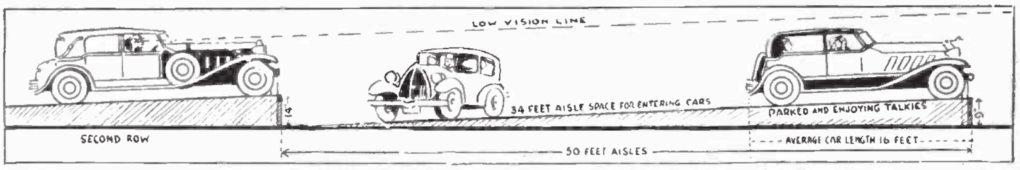
High-power sound projectors expected to parallel peewee-golf

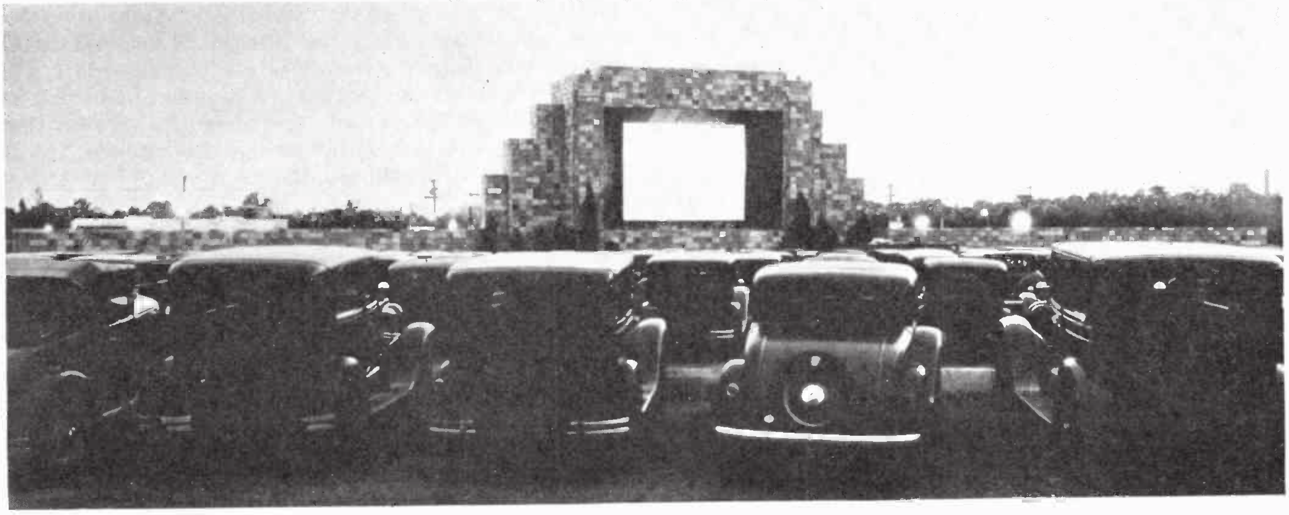
HIGH-POWER sound systems and wide-screen projectors developed for the very large movie houses, have now made possible a new entertainment device, the outdoor automobile movie. The first of these "drive-in theaters" occupies a seven-acre field near Camden, N. J., and the idea is expected to spread widely next season for roadside entertainment, much as the golf-course craze spread three years ago. Visitors drive their cars right into the enclosure, and on cool evenings or during light rain can hear perfectly even with all windows closed. Whole families, with infirm elders, can be transported bodily, with minimum effort of unloading, parking, etc.

Since almost the entire investment goes into projector and sound equipment, and simple housing of the screen and projectors, the overhead cost is very low. The Camden movie is understood to pay the local farmer only $30 per month ground rent. Four hundred cars can be accommodated. The screen width is 60 ft. and R.C.A. Photophone high-fidelity speakers delivering 80 acoustic watts are used, enabling those seated in the rear rows, 500 ft. from the screen, to hear with the same clarity, as do auditors up in front. Richard M. Hollingshead, Jr., is the inventor of the "Drive-In" movie theater and has applied for patent rights.



How the automobiles are parked on inclined ramps with wide aisles between rows. Motor cars thus become private theatre boxes, in which occupants can smoke, chat or enjoy refreshments


LOW VISION LINE
14"
34 FEET AISLE SPACE FOR ENTERING CARS
PARKED AND ENJOYING TALKIES
6"
SECOND ROW
50 FEET AISLES
AVERAGE CAR LENGTH 16 FEET



COST VERSUS QUALITY IN

A symposium of papers delivered at
the annual I.R.E. convention in Chicago

Broadcast receiver coils

By F. N. Jacob
Meissner Manufacturing Company

RADIO receiver manufacturers are constantly striving to secure the best possible performance in their sets with the smallest posible expenditure for component parts and their assembly. During the last few years the more general practice has been to purchase component parts from concerns which concentrate on the production of one or more of these units, since they are usually in a position to make these parts of the highest quality at the lowest cost and hence should be able to supply the assembler with the best cost balance obtainable.

Before discussing whether or not superior quality is accompanied by higher cost of the finished unit, it might be well to define some of the terms to be used. Quality may be defined as mechanical perfection as well as electrical performance, where the latter term is taken as the ability of an r-f tuning system to sufficiently amplify a desired signal and to reject any other signal but the desired one.

The cost of any part in this system is the selling price of a complete unit ready to be installed into the receiver in any stage preceding the demodulator tube. The selling price will be assumed to be proportionate to the cost of manufacture, which again may be resolved into that of material, labor, and the use of any necessary machinery.

Considering first the use of machinery in the fabrication of coils, it is a fact that any saving effected by the use of machinery, no matter how elaborate the device may be constructed, can be applied in the making of a poor coil as well as one of the highest quality.

On the question of labor, what holds true for other lines of manufacture is true here. To secure a perfect assembly at the finish of the job, the use of skilled labor thoroughly familiar with a particular operation is absolutely essential. To keep the cost of an operation as low as possible, an operator who can perform the work quickly is preferred. A worker capable of satisfying these two requirements is paid considerably more than one who is only proficient in one respect, consequently adding to the cost of a quality product.

A phase of coil manufacture which plays a large part in ultimate cost, perhaps more than in other lines, is the test and inspection for electrical requirement. The general run of coils receives about six electrical tests before the unit is accepted. Unquestionably the better the product is to perform, the more exacting must be the electrical tests, and the more closely tolerances must be held. Thus a high quality coil requires more time to test and adjust to specification of inductance, etc., and calls for the services of a higher grade operator and more elaborate and costly test equipment. The controlling factor as to cost would be the tolerances to be observed and the number of tests required.

▼

A MOST interesting and instructive symposium was part of the program at the annual I.R.E. Convention. This symposium consisted of papers by well-known engineers on the relation between the cost of components entering into radio receiver manufacture, and the quality of those products. The papers dealing with loudspeakers by Hugh S. Knowles, on resistors by Byron B. Minnium and on circuits by H. D. Mysing will be presented in a near issue of *Electronics*.

▲

Where savings are made

The cost of actual manufacture of a unit is dependent not so much on the kinds of operations as upon the physical and electrical specifications, since coils used for similar purposes but of different quality require about equal amounts of handling.

The largest saving in attempting to secure a cheaper coil will result in the use of less costly materials. This however is not accomplished without an accompanying lowering of quality standard. Any manufacturer of reputable receivers is interested not only in the appearance and performance of his sets at the time they leave the factory, but also after they have been in operation for considerable time. Here the mechanical construction is the essential factor. Outside of the vacuum tubes it is doubtful whether any component part can be held more responsible for the ultimate operation of a receiver than the coil system. Since the set may be subjected to all types of climatic conditions, the treatment of coils should receive considerable attention. The less costly way would be to use materials that had not been treated to withstand heat and humidity both from the mechanical as well as the electrical standpoint. The best practice of coil design calls for the use of wax or varnish impregnation of complete assemblies. A more recent and superior method is to dehydrate the unit and then flash dip it in a high grade sealing compound, immediately after removal from the drying chamber. This produces an excellent mechanical and electrical seal but is more involved than the impregnation method and is more expensive.

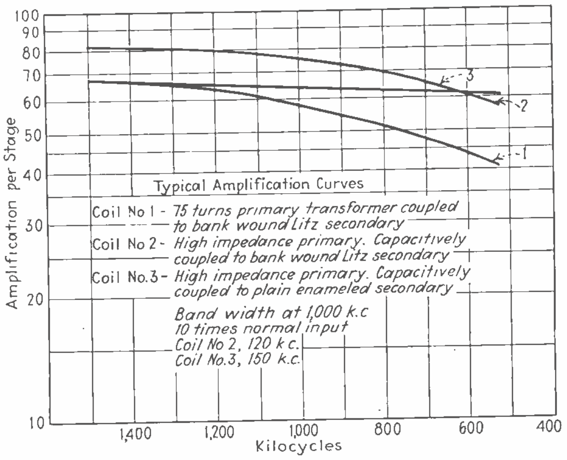
The forms on which coils are wound vary quite

RADIO SET COMPONENTS

Cheapening the product is shown to give the purchaser a poorer product for his money

widely. Universal coils as a rule make use of wooden dowels, although porcelain and fibre cores have been used where the ultimate in quality is desired. The use of the latter materials naturally adds to the cost. Under the proper treatment a wooden dowel should be very nearly the equivalent of these expensive cores, save for mechanical strength.

A large saving may be effected through the use of treated paper tubing in the place of phenol fibre. However the paper tubing does not possess the strength of bakelite and the latter would be preferred in any case where one wishes to secure the best quality. Again paper tubing is not well adapted to the winding of space-wound coils and is limited in other respects also.



Comparison of broadcast frequency coils as function of wire used

Fairly wide range in quality and cost is available in the use of different wire and types of windings. At present, in i-f transformers, the general run of coils may be grouped into three classes, namely: paper layer, random wound, and universal or duo-lateral wound. All three types generally consist of a primary and a secondary wound coaxially and having a 1 to 1 turns ratio.

Random wound transformers are becoming rare, their biggest advantage lying in the simplicity of winding equipment necessary. The cost of bobbins for these coils is relatively high and the finished coils when wound to a given number of turns will not run uniform in performance and inductance.

Paper layer i-f transformers find favor with those manufacturers having equipment for winding power transformers and coils of like construction, as the same machine may be used in winding both types. These coils have excellent electrical properties even when only plain enamel wire is used. However they must pass through an elaborate finishing process after leaving the winding machine so that the final cost is usually in excess of that of a similar coil wound duolaterally.

The universal type is the most widely used and the cost and performance is almost entirely dependent on the wire used. Consider for instance, the following measurements made on i-f transformers, under standard operating conditions where the unit was inserted in a stage working between a type 58 tube and a 57 tube used as a detector. These measurements, while they may not be considered absolute, will serve for purposes of comparison. The coils were all wound on the same size dowels, tuned by the same type of condenser, both primary and secondary, and adjusted for maximum coupling in a shield can large enough so as not to affect the coil to too great an extent.

At 456 kc. a transformer wound with No. 36 single cotton enameled wire having an inductance of approximately 1.75 milli-henries, had a gain of 103 and a band width of 200 kc. at 100 times normal input. Another coil of about the same inductance and dimensions wound with 7-41 silk litz wire had a gain of 156 times and a band width of 140 kc. at 100 times normal input. Still another transformer using No. 36SSE wire having slightly lower inductance provided a gain of 115 times and a band width of 190 kc.

At 175 kc. a coil wound with No. 36SCE wire with an inductance of approximately 7 mh., had a gain of 100 times and a band width of 70 kc. at 40 db. down. A similar coil of 7-41 silk litz had a gain of 125 times and a band width of 64 kc.

From the above comparisons it is visible that in each case the more expensive wire, namely the litz, produced a coil having not only more gain, but a smaller band width.

The r-f, antenna and oscillator coils to be had which follow general practice, will be found to vary not only in the wire on the primary and secondary but also in the manner of coupling between the two windings. We may dispose of the oscillators by saying that the coils having a tank winding with a better figure of merit will produce a more uniform voltage over the entire tuning range than one having a poorer figure as a result of the utilization of cheaper wire.

In r-f. and antenna transformers, a less costly coil may be had by using inductance coupling between a low turn primary and the secondary, but the resultant amplification will change markedly from one end of the band to the other. An impedance coupled coil will produce more uniform gain but can only be had at an increase in cost due to the use of a high impedance primary coupled to the secondary through the medium of a capacitor.

A shielded r-f coil with a bank wound litz secondary and a seventy-five turn primary, inductively coupled to secondary, had a gain of 66 at 1,400 kc. and 44 at 600 kc. An impedance-coupled coil having a bank wound litz secondary, provided an amplification of 68 times at 1,400 kc. and 64 at 600 kc. The band width at 20 db. down was 120 kc. at 1,000 kc. Another impedance coupled coil with a plain enamel secondary of about the same dimensions as the last coil mentioned, had an amplification of 82 times at 1,400 kc. and 62 times at 600 kc. The band width at 1,000 kc. was 150 kc. at 10 times input.

Here again it will be noticed that litz wire produced the best performing coil as regards band width for a given gain. It can be said that a universal wound r-f or antenna coil will effect a saving of space and may be placed in a small sized shield can but it is not as efficient as the solenoid type and will not be much less in cost because of increased production difficulties.

Quality requires completely shielded coils to insure receiver stability, but gives rise to higher cost because of the added expense of the shield can.

In conclusion, it would seem that the mechanical quality is jeopardized by using cheaper labor and material and that improved electrical performance requires more expensive materials and methods of manufacture. While it is only possible to improve the quality of a unit to a certain degree by more expensive construction, without increasing the cost beyond any advantages received, nevertheless, until that point is reached there can be no compromise with cost if real quality is being sought.

Transformers

By W. J. Leidy, *Chicago Transformer Corporation*

THE subject of cost versus quality as applied to transformers used in a radio receiving set is a question that should interest all set manufacturers.

Transformers used in radio receiving sets are divided into two general classes, power and audio. The quality of an audio transformer is usually defined in terms of frequency response.

The term cost is usually limited to the initial cost of the unit as furnished by the supplier and does not take into consideration the ultimate cost to the set manufacturer as a result of replacements due to failures.

Cost and quality are related in tube manufacture. This scene was made in Majestic's tube plant

A difference in cost of a fraction of a cent has been known to induce the use of some small over rated part which endangered the life of other quality parts in the assembled set. No single part can stand on its own and must rely on the good qualities of numerous other parts.

The term quality must be defined. We associate the grade of material and the kind of workmanship with the quality, the assumption being that the best grade of materials and the best workmanship will produce the highest quality.

It is only possible for the set manufacturer to determine the quality of the parts by their performance over a period of service. Numerous changes in design each year have made it difficult for the manufacturer to accurately determine the cause for transformer failures in the field. Unfortunately for the transformer manufacturer, most failures of parts in a set are reflected back on the power transformer resulting in an overload and burnout. Primary fuses do not give the protection required. A one hundred per cent overload in one secondary winding will increase the primary load by less than 50 per cent on the average set.

The set manufacturer limits to some extent the overload capacity of a power transformer when he specifies the maximum temperature rise and also the size. Five years ago it was not unusual for a set manufacturer to limit the temperature rise to thirty degrees. Today we have set manufacturers giving limits as high as twice this amount. A certain temperature limit may be entirely satisfactory in one location in a chassis but may be doubtful in another when surrounded by other parts. The transformer manufacturer cannot set the temperature limits as this will vary with the conditions under which the transformer is used.

This gradual increase in temperature limits over a period of years has had a decided effect on the transformer design, especially the materials used. The materials must be of a better grade and they must be more uniform in quality.

Old materials picked up at bargain prices from sources that are questionable are bound to affect the quality. Even though these materials have the same trade name applied to a particular grade, the quality will vary. For example, silicon steel sheets of a certain grade of five years ago are not the same quality sheets produced today under that same grade name.

Electrolytic condensers

By R. O. Lewis,
P. R. Mallory & Company

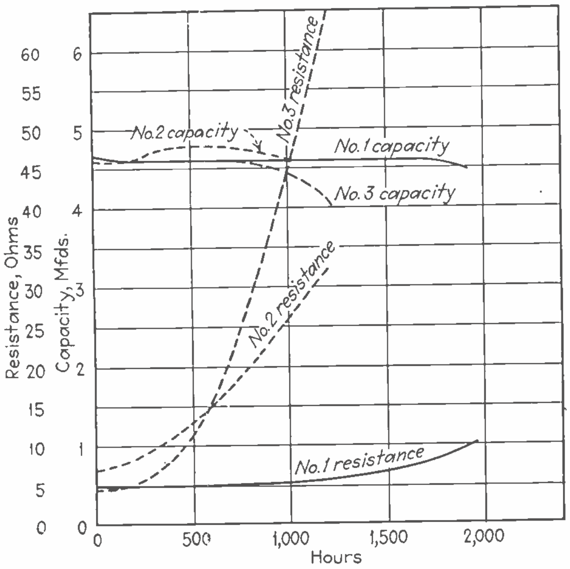
THE cost of condensers like the cost of almost any other thing depends upon the degree of quality the buyer is willing to accept. For most suppliers this condition is tempered by judgment as to what they are willing to supply. Acceptance specifications are the criterion as to what the purchaser demands and standard manufacturing specifications are the limiting factors as to what the supplier is able to furnish.

When acceptance specifications are more severe than the supplier is able to supply at a standard price the item becomes a "special" and the price must be adjusted to meet the conditions.

By numerous conferences the electrolytic condenser industry has established standards under which they are able to produce condensers of standard rating without special processing.

Whenever the radio industry follows these standards the lowest prices and quickest deliveries are possible. These standards are easily obtainable from the condenser manufacturers. At the same time the condenser industry has standardized on methods of testing and rating condensers as follows; the capacity test shall be made at 70 deg. F. or a correction applied at other temperatures: a d-c polarizing voltage of 80 per cent of rated voltage with a superimposed r.m.s. ripple voltage of 15 volts, 60 cycles for capacitors rated at 100 volts or higher; 3 volts for the range from 25 to 100 volts, and 2 volts ripple for units between 6 and 25 volts.

Standard capacity tolerances are minus 10 per cent and plus 100 per cent of rated capacity when rated up to 99 volts; minus 10 per cent and 50 per cent plus for units to operate between 100 and 200 volts; and for units rated above 200 volts, minus 10 per cent and plus 50 per cent for 3 µf or less, minus 10 per cent and plus 20 per cent for units of over 3 µf.

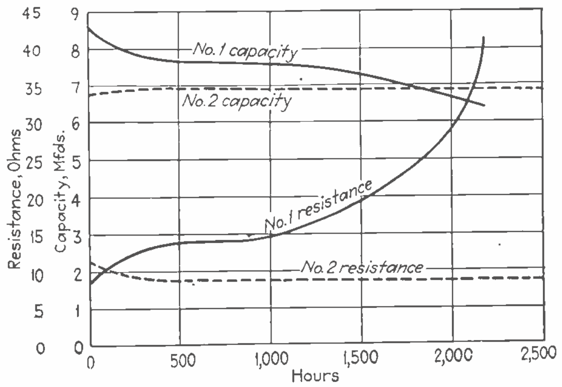


Dependence of condenser life on proper electrolyte

Under the same conditions as specified for capacity and at 120 cycles, the guaranteed maximum power factor will not be less than 10 per cent for single gauze and 15 per cent for double gauze capacitors rated 100 volts or higher and for capacitors of 2 mfd. or higher.

While no standards have been definitely arranged for leakage specifications, engineers should avoid excessively low leakage requirements due to the possibility that the cost will be greater than necessary because of excess time or material required for their manufacture. Normally a leakage specification that calls for less than 0.15 milliamperes pere microfarad is considered a low limit.

Among other definitions agreed upon by the condenser industry, maximum surge voltage is most important. This represents the maximum potential the condenser will withstand without breakdown or permanent injury, for a period of five minutes when applied to a series combination of the condenser and a resistance, the resistance having a value in ohms, equal to 20,000/C (where C is the rated capacity in microfarad.)



Effect of increasing by 20 per cent plate formation and electrolyte cost (450 volt units)

The voltage at which the plate is formed determines to a very large degree the maximum voltage which the condenser will stand. The plate area is directly proportional to the formation voltage for any given capacity rating. Furthermore the capacity of a condenser for any given voltage rating varies directly with the area of the plate. Therefore prices on electrolytic condensers have been established on a plate-area basis. This means that the voltage rating of the condenser and capacity rating of the condenser do not entirely determine its price. If the leakage specification is too low or the power factor specification is too low, it may be necessary to use a greater area of plate than is allowable for a condenser of the capacity and voltage rating for standard prices.

An interesting point in connection with the plate area control of price is the fact that some manufacturers delight in promising condensers at the standard price but with capacity higher than the capacity rating. It would be well for the engineer to remember that to get the higher capacity under a plate limitation price set-up it is necessary to form the condensers at lower-than-standard voltages. It is well known that condensers with formation voltages too close to the working voltage increase in resistance rapidly and drop in capacity rapidly in service.

It can be seen from these facts that the plate area limitation is also a quality control to a very large degree. For instance, on the low voltage condensers there is a capacity tolerance of plus 100 per cent, but to get this 100 per cent plus capacity with the same plate area it is necessary to reduce the plate formation to the point where the condenser will have a very much shorter life in service.

It is a fact that plate formation is not the only criterion as to the life of electrolytic condensers. A curve sheet is presented herewith showing three identical condensers as far as plate formation is concerned and having three different electrolytes. These curves show that the rate at which the resistance increases and the capacity decreases throughout the life of the condensers is very much dependent upon the electrolyte. The condenser represented in curve 1 has an electrolyte which costs about 15 per cent more than the electrolyte in curve 2 which has an electrolyte that costs about 15 per cent more than No. 3.

Needless to say, the 15 per cent increase in cost of condenser No. 1 over No. 2 is thoroughly justified from the results obtained. Another curve sheet is presented to illustrate the difference in performance of 450-volt condensers in which both plate formation and electrolyte

[*Please turn to page 215*]

Tubes to fit the wavelength

Less than one inch in size; for use at one meter and below

By B. J. THOMPSON

RCA Radiotron Company,
Harrison, N. J.

As the development of radio communication led to the use of continually shorter wavelengths, refinements of the conventional types of tubes and circuits proved adequate to meet the needs for receiving equipment down to a wavelength of somewhat less than five meters. For wavelengths of less than a meter, however, further refinement was considered to be entirely impracticable, and, consequently, new types of tubes and circuits have been used. In general, these make use of electron oscillations within the tube, and parallel wire tuning means. These tubes and circuits make possible reception at very short wavelengths, but, in comparison with conventional long-wave apparatus, they have a number of serious disadvantages. Among these are the impossibility of obtaining signal frequency amplification, and the high power and voltage which must be supplied to the tubes to produce oscillations. In view of these difficulties, it was decided to make an attempt to lower the minimum wavelength limit at which conventional type tubes and circuits may be used. The method and results of this attempt are described here.

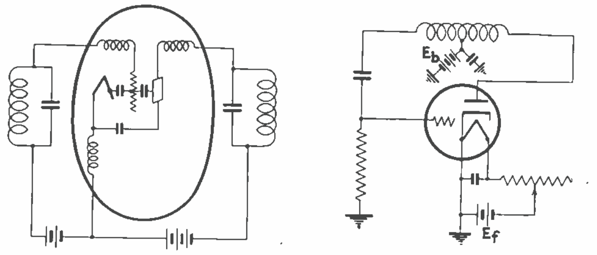


Fig. 1—Lead inductances (left) and capacitances in an amplifier tube and (right) circuit used in the short-wave oscillator

Figure 1 shows a simple tuned radio frequency amplifier circuit. The inductances and capacitances shown within the bulb of the tube are those inherent in the tube leads and electrodes. Neglecting other effects, it will be seen that as the wavelength is reduced by reducing the external inductance and capacitance the external circuit becomes a smaller part of the total, with a loss in available amplified signal, until, in the limit, the plate lead inductance and plate to ground capacitance form a tuned circuit alone, and no amplified signal is available. The remedy for this condition, of course, is to reduce the internal inductance and capacitance. To obtain useful amplification, no appreciable reduction in transconductance should accompany this reduction.

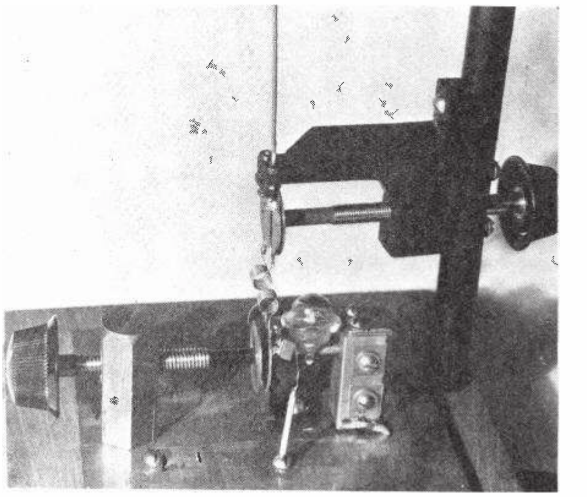


Fig. 2—Transmitter working on 100 centimeters

To effect this reduction of internal inductance and capacitance, advantage is taken of the following principle: if all linear dimensions (length, breadth, and thickness) of a vacuum tube are held in a constant ratio, plate current, amplification factor, and transconductance are constant, regardless of the magnitude of the linear dimensions, while lead inductance and inter-electrode capacitance are in proportion to the magnitude of the linear dimensions. Therefore, under conditions where the tube is a limiting factor, *tube and circuit dimensions should be in proportion to the wavelength.*

Since conventional sized tubes operate fairly well at five meters, a ten-fold reduction in dimension is required to produce tubes to operate at 50-cm. wavelength. Tubes approximating this reduction have been made and tested. The maximum overall dimensions of these tubes are about three-quarters inch.

Both tubes have indirectly-heated cathodes. A parallel plane structure is used, with the cathodes and anodes shaped as flat bottomed cups, and the grids as flat disks. No stem is used in the assembly, the leads being sealed directly through the bulb. When it is said that the inter-electrode spacings are of the order of 0.005 inch, it will be understood that mounting these tubes is a delicate task.

TRIODE CHARACTERISTICS:

Plate voltage	= 67.5 v.	Amplification factor	= 14.7
Grid voltage	= —2.0 v.	Grid-cathode capacitance	= 0.7 $\mu\mu$f.
Plate current	= 4.0 ma.	Plate-cathode capacitance	= 0.07 $\mu\mu$f
Plate-resistance	= 9,500 ohms	Plate-grid capacitance	= 0.8 $\mu\mu$f
Transconductance	= 1550 μa/v.		

SCREEN-GRID TUBE CHARACTERISTICS:

Plate voltage	= 135 v.	Plate resistance	= 360,000 ohms
Screen voltage	= 67.5 v.	Amplification factor	= 400
Control grid voltage	= —0.5v.	Input capacitance	= 2,5 $\mu\mu$f
Plate current	= 2.5 ma.	Output capacitance	= 0.5 $\mu\mu$f
Transconductance	= 1100 μa/v.	Plate-grid capacitance	= 0.015 $\mu\mu$f

These tubes compare favorably with conventional tubes in all electrical characteristics, and represent a large reduction in interelectrode capacitance. Due to the very short leads, a large reduction has been made in lead inductance also.

The triodes have been operated as oscillators to determine their short wave limit. The coils are one-eighth inch in diameter. The only tuning capacitance was that formed by the tube electrodes. It was found that a minimum wavelength of slightly below 30 cm. was reached with one turn in the coil. At this wavelength the minimum plate voltage that could be used was 115 volts, and the plate current 3 ma. At 40 cm. and more, oscillations were very stable the tube operating at 45 volts and 0.5 ma.

A 100-cm. transmitter using one of the small triodes modulated from a broadcast receiver was set up. A two-stage tuned radio frequency receiver using two of the screen-grid tubes, and two of the triodes for detector and audio amplifier, was used to receive the signal. The receiver was found to operate well, an estimate of the r-f gain being about four fold per stage.

Another transmitter and receiver were set up to operate at 75 cm. The receiver consisted of one tuned radio-frequency stage and a detector. In this receiver no variable capacitors were used to tune the circuit, the tube capacitance alone being used. The gain was slight, being estimated at little more than unity.

Considering the excellent performance of these tubes as oscillators and detectors, and the fair performance as radio-frequency amplifiers, it is to be expected that good superheterodyne receivers could be constructed at wavelengths approaching 50 cm. In such a receiver the principal function of the r-f stage would be to block the local oscillator from the antenna.

It is therefore concluded that after suitable refinement of size conventional types of tubes and circuits may be applied to the reception of wavelengths of less than one meter.

This paper could not be complete without an acknowledgement of the ingenuity, skill, and perseverance of Mr. George M. Rose, Jr., whose efforts were largely responsible for the successful construction of these very small tubes.

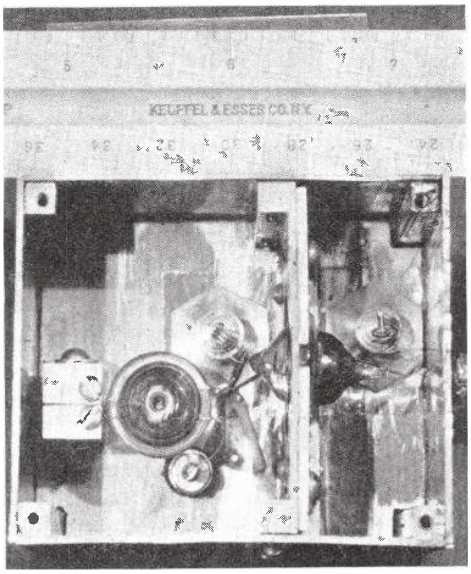


Fig. 3—Receiver for 75-cm. waves. The input tuned circuit is at the right. The entire receiver is of the order of 3 inches square

Last of all, it must be stated that these tubes are not now available. They are not now being manufactured, nor is their manufacture contemplated at the present time. This paper has no commercial significance, being merely the report of what was considered an interesting and perhaps important technical study.

Cost versus quality in radio set components

[*Continued from page 213*]

cost have been increased making a total of 20 per cent increase in cost over condenser No. 1.

The plate areas selected for the standard voltage and capacity ratings have been selected from field experience with electrolytic condensers. The plate area limitation is liberal enough in each case so that the standard condensers will deliver satisfactory service when they are used in circuits which do not cause overloads beyond their ratings.

In writing acceptance specifications there is certain information which should be available to the condenser engineer for design purposes. The mechanical factors which, of course, are always with us, should be clearly shown. Surge voltage to which the condenser is to be subjected should appear. Capacity rating, with the tolerance, is necessary. The leakage specification and either resistance or power factor limitation should be on the specifications. In connection with the mechanical requirements, it is a fact that unless the space allowable is sufficient, it is impossible to furnish a condenser with sufficient plate and thick enough spacer to deliver maximum service. This factor more than any other has caused condensers of barely sufficient quality to be made.

Another factor which should be recognized especially at the present time when practically all of the suppliers to the condenser industry are asking for more and more time, is delivery of condenser materials. It is advisable to use a standard construction whenever it is in any way possible to do so.

Certain condenser designs reduce the manufacturing cost and create savings that will result in lower prices. Wherever it is possible to use a common cathode construction the cost is low. Whenever more than one unit may be placed in a single container the overall cost is lower. Lapped cathode construction results in higher resistance units and multiplied manufacturing difficulties so that the cost is no lower than separate units in a single container.

It is also a fact that electrolytic condensers in paper containers are entirely satisfactory; a fact that has been proven by field experience over a long period of time. With metal-wrapped condensers in a paper container it is easily possible to make units which are as high in quality as those which are housed in metal cans. This results in lower costs to the purchaser.

Life tests and field experience have demonstrated many times the fact that electrolyte composition and plate formation process are the most important items in manufacturing quality condensers. If the electrolyte is not stable no housing of any kind will make the condenser deliver long life.

It must again be emphasized that if engineers want quality condensers at low cost on rapid delivery schedules, they should use the standards as set up by the condenser industry. In any case, the condenser engineer should be given the full information as to working voltage, surge voltage, capacity tolerance, leakage requirements, resistance tolerance and peak ripple.

HIGHER-VOLTAGE VACUUM

In California and in the East, higher potentials are leading to new achievements in X-rays and transmutation

1. Higher-voltage vacuum tubes.
2. Faster speeding electrons.

3A Shorter and more penetrating X-rays.

3B Greater penetration of electron bullets into the nuclei of atoms, with resulting transmutation of elements.

* * *

There, in a nutshell, you have the sequence of cause and effect behind the work with high-tension vacuum tubes now going forward on half a dozen fronts in America, as well as in several laboratories abroad.

At Pasadena, Calif., the effort is to speed up the electronic or cathode-ray discharge and so get X-rays so short as to simulate the gamma rays of radium.

At Berkeley, Calif., the machine-gun fire of high-speed electrons has been concentrated on the atoms of one element, turning it into another,—converting beryllium into carbon, for example.

At Schenectady, N. Y., a succession of pushes administered electrostatically to the electrons, results in new kinds of X-rays being set up when the electrons strike their target, so that X-radiation of improved curative power is produced. One of these great multi-stage X-ray tubes is now in operation at the Chicago World's Fair.

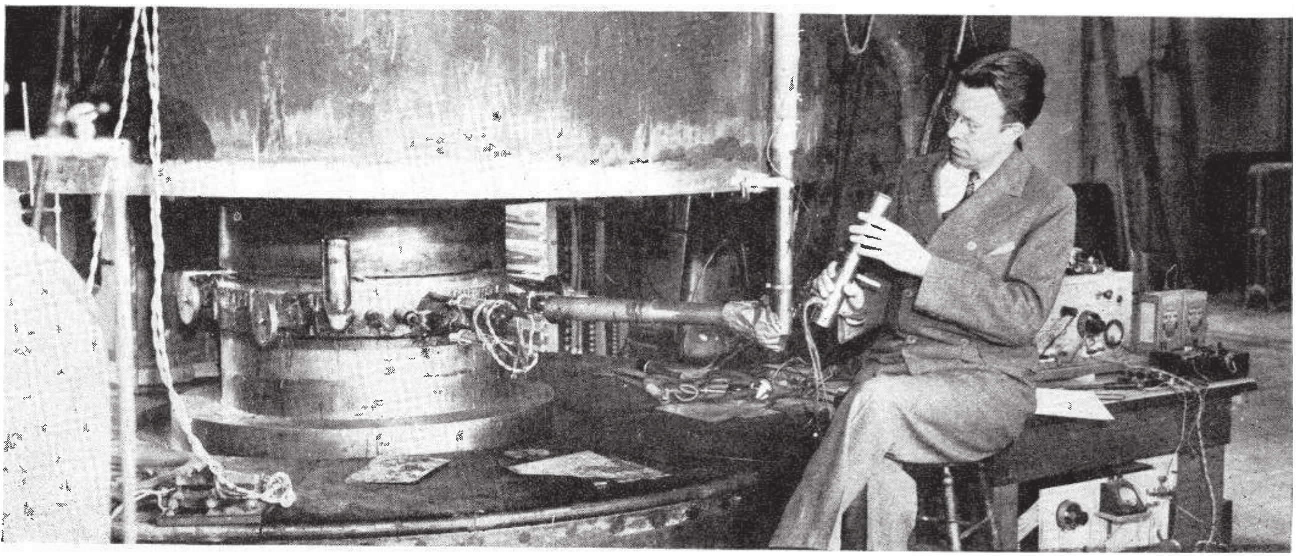
At Washington and at Pittsburgh high voltages in vacuum tubes have produced electron velocities reaching within a few per cent of the speed of light, 186,000 miles per second.

And at the South Dartmouth, Mass., estate of Colonel Green, Dr. Van de Graff has constructed his new electrostatic generator on a huge scale, with 15-ft. brass spheres carried on railroad trucks. This machine is expected to produce eventual potentials of ten to fifteen million volts, to be applied to the same problem of cracking the atom.

At the University of California, Berkeley intense magnetic fields have been used to accelerate the particles, attaining the equivalent of electrical charges of 1,330,000 volts. Such high-velocity particles, striking the walls of the lithium atom, release alpha particles or helium nuclei having electric charges of 12,600,000 volts, a charge nearly ten times as great as the projectile particle. The next step will be to utilize these 12,600,000-volt alpha particles in turn as projectiles directed at other atoms, thus by a progressive series of steps "unlocking the cosmic cupboard of energy," as well as bringing about actual transmutation of elements from one to another.

At the California Institute of Technology, Pasadena, where high-voltage X-ray tube development has been underway, a novel porcelain tube has been constructed which operates successfully up to 650,000 volts. This X-ray tube was built from a 750,000-volt transformer bushing, and is maintained pumped down to a vacuum of 10^{-5} mm. Cold emission from the anode, rather than gas current or breakdown of the porcelain, limits the voltage which can be applied. For a given voltage, a porcelain tube of this kind is found much more compact than a glass tube, while the strength of its walls against puncture makes elaborate internal shielding unnecessary.

There at "Cal-tech," plans are also going ahead for the construction of another revolutionary type of X-ray tube, to be operated at 2,000,000 volts, and to produce radiation more penetrating than radium. Completion of this new tube will also permit investigations into the



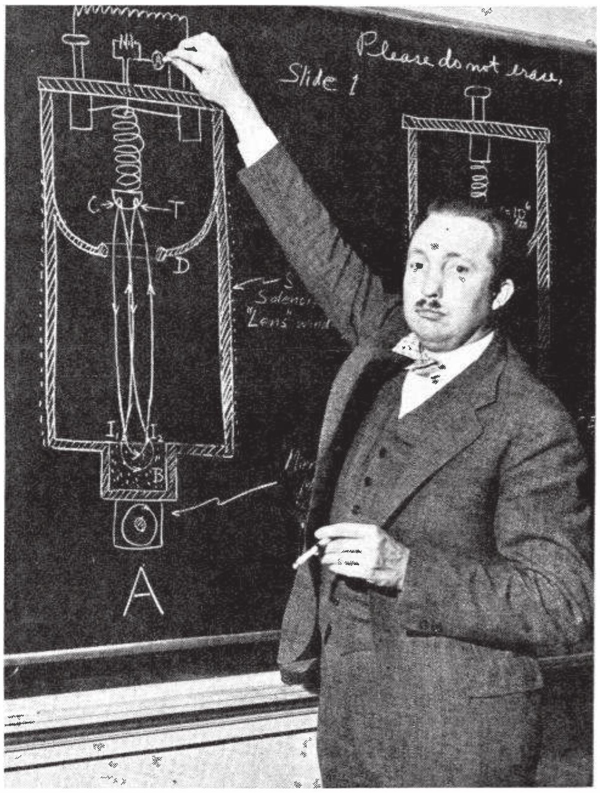
Intense magnetic fields produce tremendous velocities of particles in this "element transmuter" or "atomic-energy liberator" of the University of California, at Berkeley

TUBES—FASTER ELECTRONS

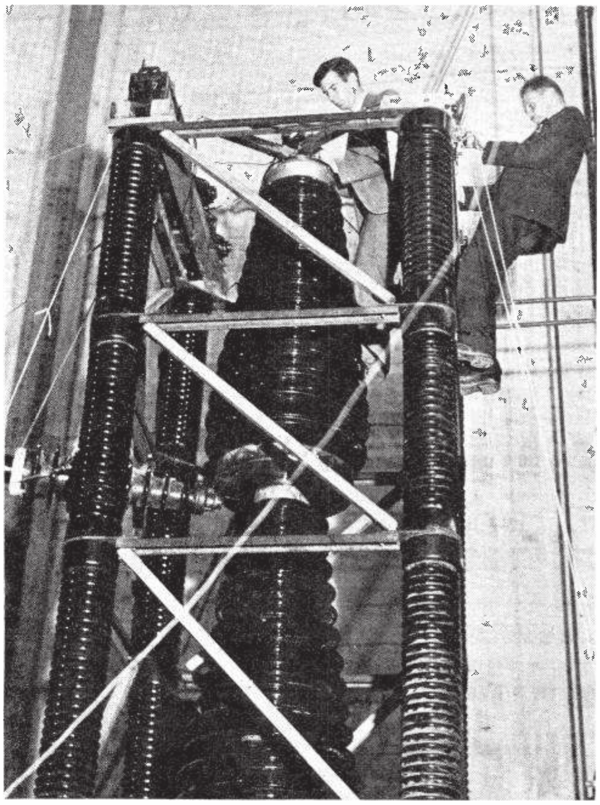
Fundamental problems of physics and physiology being attacked with new tools provided by high-speed cathode streams

theory of restricted relativity, as applied to electrons of very high energies. The new tube construction is described by Dr. Jesse W. M. DuMond, its designer, as follows:

"The proposed apparatus is a modification of the freely suspended vacuum Tesla coil patented by Sloan of the University of California. The bottom end of a large helical copper coil (shaped like a huge bed spring) suspended in a large metal vacuum box alternately assumes positive and negative potentials of 1,000,000 volts with extremely high frequencies. This much is Sloan's coil. I propose to add to this a source of electrons consisting of a small electrically heated filament mounted on the bottom end of the coil. When the potential is near its highest negative value electrons will be repelled from this 'cathode' with an energy of 1,000,000 volts through a large hole in a partition and will coast along with this energy in a vacuum space relatively free from electric fields. A magnetic 'lens' will serve to neutralize any tendency for the beam of fast electrons to diverge from the source and will refocus them much as an ordinary lens focusses light. At or near the new focus this beam of electrons will encounter a strong magnetic field which will act in the same way as a mirror acts for light rays, turning the electron beam back along a return path nearly identical to the first. The same magnetic lens will refocus the electron beam on a target suspended near the cathode from the bottom end of the Tesla coil.



Radical new design for a 2,000,000-volt X-ray tube, sketched by Dr. Jesse W. M. DuMond, California Tech, Pasadena



The "neutron mill" of the California Institute of Technology, Pasadena. Under a million-volt potential, electrons can be stripped from helium atoms, forming artificial alpha particles

When the device is to be used for X-ray or artificial gamma ray generation the rapid oscillations of the Tesla coil will be so timed as to catch the electrons on their return to the target a half-cycle later when the latter is positive, thus imparting to them another million volts on top of the million they already possess. They will thus impinge on the target with an energy of 2,000,000 volts and will generate there X-rays of corresponding 'hardness.' As an apparatus for measuring the dynamical properties of high energy electrons, the proposed device bears interesting analogies to the methods of the late Dr. Albert A. Michelson in determining the velocity of light. Instead of light, I propose to use electrons."

Another powerful tool at Pasadena developed to batter

[*Please turn to page 230*]

How manufacturers can cash in on radio Prosperity Campaign

By EARL WHITEHORNE

RMA Campaign Director,
330 W. 42d Street, New York City

THE radio industry has organized under the Radio Manufacturers Association to lift itself out of the depression this Fall with a Radio Prosperity Campaign and radio sales drive during the month of September. Local committees in each community will work together to increase the sales of new radio sets, tubes, parts and accessories. The campaign will reach its climax in Radio Progress Week, Oct. 2 to 7—a week of special broadcast programs designed to develop popular appreciation of modern radio broadcasting and equipment, and to enlarge the radio audience.

Following is a list of suggestions for radio manufacturers and their organizations, pointing out how the makers and designers of radio sets can cash in on this Rebuild Radio Prosperity Campaign:

1. Study the Campaign Plan in the Campaign Announcement folder and figure out how you fit into it.

2. Sit down with your sales manager and advertising manager and work out a campaign of your own to tie your product into the national program.

   a. Decide how you will force your line to the front in the September Sales Drive and capitalize the Radio Progress Week broadcasting.

   b. Work out in detail how you will feature your product in this organized demonstration of the present perfection of radio equipment so that you will get your share of the business.

   c. Design and schedule your company advertising for this summer and fall, so that it will help your distributors and dealers increase their local sales in competition with the automobile, refrigerator, travel, clothes and the other appeals that are after the same money. Build it around the popular appeal of Radio Progress Week.

3. Call in your district managers and sell them on the Rebuild Prosperity Program and your Company Campaign. Send them back to their districts with enthusiasm so they can inspire their salesmen and distributors and take leadership in the work of the local committees.

4. Write a letter to all your distributors and tell them that you are behind this Radio Prosperity Program and are developing a Company Campaign that will give them the edge on this fall's selling in their territories. Ask them to start working out the local plans to tie in all their dealers.

5. Throw your whole sales staff into this campaign with the idea that you are going to run away with this Radio Prosperity Program. Offer prizes for the district manager who does the best job and the salesman who makes the record.

6. Inform your entire organization—factory, shipping, service, accounting and other departments—on this Rebuild Prosperity Campaign. Tell them that you are going to jump the gun and win a new leadership in radio manufacturing. Get them all pulling for faster shipments, lower costs and better service to help put it over and bring back your prosperity.

"The sun's come over the mountain!"

7. Call in your distributors for one day meetings in the East and West and South to instruct them on the part they are to play. Sell them all the idea of jumping into the local committee work and taking leadership with your line. Raise the banner of a real campaign—your campaign tied into the National Radio Prosperity Program—and make them feel that the Sun's Come Over the Mountain and you are going to fight right back into Good Times again.

8. Start at once a systematic cultivation of your distributors and dealers by mail and personal contact to tune them up and speed them up for the work they must do in this campaign. Make sure that they get ready in August, that they drive for quick sales, with all the energy and brains they've got in September, and that they follow through Radio Progress Week and continue their high pressure selling on through the season, while business is coming.

9. Make definite arrangements to insure that the Campaign Dealer Help materials are used by every dealer who sells your line and intelligently combined with your own display and advertising matter. Be sure your district managers and distributors understand that every dealer's store must be tied into Radio Progress Week by featuring the emblem and the slogan of the campaign and mailing out the folders to customers and prospects.

Get new models ready now, for September showing

10. If new models are to be presented this Fall in your line, have them out in August ready to be shown early in September. Prepare distributors and dealers so that the dealers will hold new model receptions to help close sales ahead of Radio Progress Week.

11. Merchandise your own product advertising to your dealers so that they will key it into Radio Progress Week and use it in their daily selling. Hammer home the point that Radio Progress Week broadcasting is provided to demonstrate the quality of radio sets. Make sure they will properly present the quality of your set.

12. Renew the pressure upon every distributor and on your own sales department during Radio Progress Week to impress upon them that they need not let down in their selling when the special broadcasting week is past. Keep up the pace and capitalize the unusual popular attention which has been captured by the continued advertising, canvassing and merchandising of the September Sales Drive.

A thyratron laboratory rectifier

By R. MILFORD KIME

THE quiet operation and high efficiency in small and moderate capacities make a thyratron tube power rectifier a very desirable piece of equipment for a student or technical laboratory. The laboratory makes two additional demands upon the rectifier as a source of direct current power. It must possess good regulation and provision must be made for protecting the tubes in case of short circuits that are apt to occur when students are at work. In other words, the rectifier should have constant voltage over the normal range of operation and constant current at some value a little in excess of the maximum rated load current.

To accomplish the required voltage characteristic, advantage is taken of the fact that the grid of the thyratron can be used to control the portion of the alternating current cycle during which the tube carries current, and hence to control the average value of the d-c output voltage. By combining a component of the output ripple with a grid bias, a grid voltage is obtained which phase controls the firing of the tubes. This is illustrated in Fig. 1: where E_a is the a-c anode or plate voltage, E_b is the negative d-c grid bias, E_c the tube characteristic, and E_r is the ripple component. For simplicity only one phase is shown. The other phases would follow in sequence, their exact time relation depending upon the number of phases employed in the rectifier.

Due to the peaked form of the grid voltage wave, decreasing the grid bias E_b causes its point of intersection X with the tube characteristic curve to move to the left, firing the tube earlier and increasing the portion (shaded area) over which the tube conducts. Firing the tube earlier in the cycle advances the phase of the ripple voltage by slightly altering its form so that the peaked portion is moved to the left. Thus each tube is caused to conduct earlier in its respective cycle and over a higher portion of the voltage wave. Since the d-c output voltage is proportional to the area under the voltage wave when the tube is conducting, it is therefore raised. In like manner, an increase of grid bias retards the phase of the grid voltage causing the tubes to fire later and reduces the average value of the output voltage.

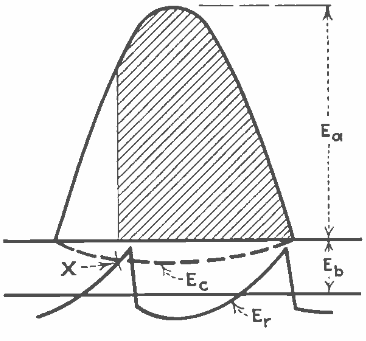


Fig. 1—Phase control of thyratron firing. The point in the cycle at which current starts governs the output voltage

The grid bias is obtained from a regulating device consisting chiefly of a resistance in series with a neon lamp.[1] The neon lamp, due to its non-linear volt-ampere characteristic, has been used as the constant element in several voltage regulating devices.[2] The tube tends to maintain constant voltage across its terminals, causing any variation in rectifier output voltage to appear across the series resistance. Thus a rise in output voltage produces the desired increase in grid bias tc retard the point in the cycle at which each tube fires (breaks down) and restores the terminal voltage to the normal value. A drop in terminal voltage produces a corresponding drop across the resistance and a reduced grid bias to fire the tubes earlier. Small adjustments in the output voltage can be made by means of a variable potentiometer in the grid circuit.

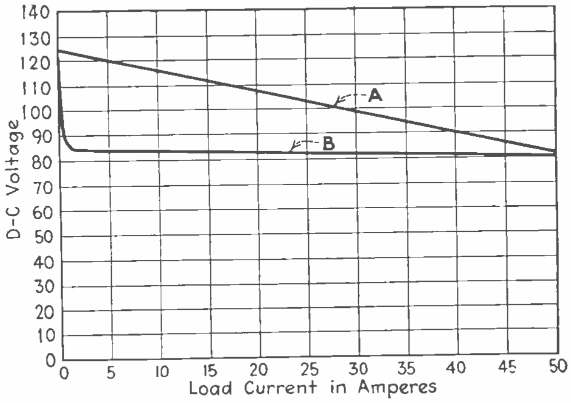


Fig. 2—Regulation curves of a two-element rectifier compared to that of a grid-controlled rectifier

Figure 2 shows the regulation curve of a small (5 kva.) experimental rectifier. Curve A shows its very poor regulation characteristic and curve B illustrates the result obtained by means of grid control of the same rectifier. The transformers for the final laboratory rectifier were designed to give 120 volts instead of 80 as here shown.

One method of protecting the tubes on short circuits consists in dropping the terminal voltage at a pre-determined overload current. Use may be made of a non-linear resonance circuit; a circuit consisting of a condenser, a resistance and a saturable iron-cored inductor; from which the current at resonance is rectified and applied to the grids of the thyratrons, as a negative bias sufficient to prevent them from firing. A current transformer in the a-c lines supplies current to the non-linear resonance circuit tuned for a current proportional to the overload current at which cut-off is to take place.

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[1] A two element tube filled with neon gas at a low pressure.

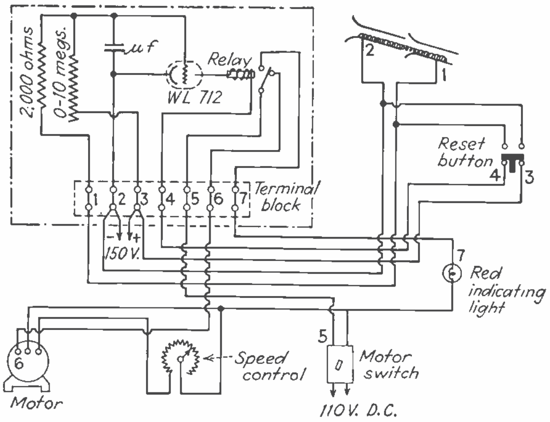
[2] A Corona Tube Voltage Regulator, by H. W. Dodge and C. H. Willis. *Electrical Engineering*, February, 1932.

An electron-tube time-delay relay

By G. C. HOLLOWAY

THE electron tube as an inexpensive time-delay relay is being used successfully for the automatic stopping of mandrelless filament coil-making machines in the Westinghouse Lamp Company, Bloomfield, N. J. By stopping the machines and signaling an attendant when trouble occurs the time-delay relays have reduced shrinkage and increased the rate of production over an experimental period of about two years.

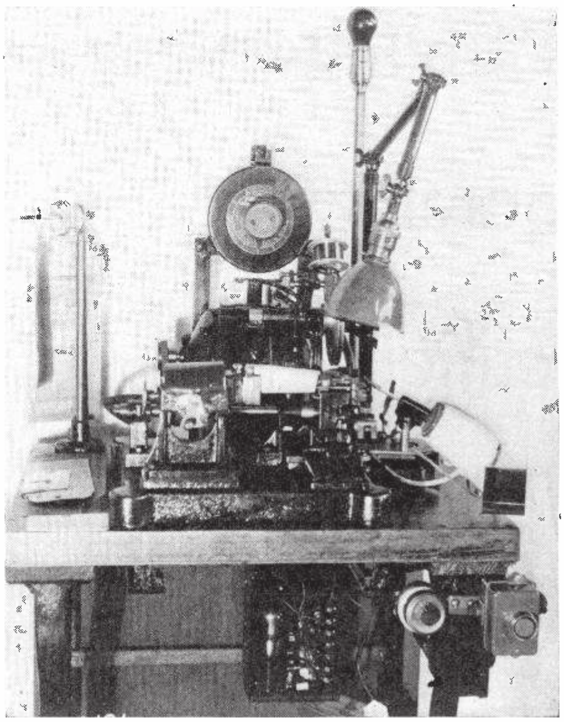
The tube used for these time-delay relays is known as the type WL-712 glow tube. Filled with argon, it contains two anodes and a cold cathode. The time factor is obtained by charging a condenser, the current passing through an adjustable resistor which permits a regulation of the time-delay period to conform with individual requirements. The voltage across the condenser is applied between the cathode and the starting anode and when it reaches a certain value, the relay trips and stops the machine.



Schematic wiring diagram showing general circuit arrangement for a simple electronic time-delay application

Operating characteristics of the WL-712 tube permit its use in a simple, inexpensive circuit arrangement. A wide variation in time adjustment may be obtained merely by changing the values of the condenser and the resistor through which the charging current passes.

The magnetic relay of the time-delay device is a standard commercial type, having its coil rated at 60 volts, d.c., 5 watts, and its contacts at 110 volts, 10 amp. The WL-712 tube is particularly suitable for use with a power relay of this type because its relatively high output eliminates the need of delicate relays and contacts. After functioning as an automatic stop, the time-delay relay may be reset by the push button which also serves to start the machine.



The complete mechanism for an electron-tube time-delay relay fits compactly into a metal box 6 in. by 8 in. by 4½ in. and can be mounted in a small area, as seen on this mandrelless coilmaking machine

Mandrelless coil-making machines are so delicate in construction that the ordinary mechanical or electrical methods of automatic stopping have not been applicable. As a result considerable material has been wasted when trouble occurred in the past.

On these machines the filament wire is projected against a diamond die. When deflected it forms helical-coiled filaments, which resemble hair-like springs. As they leave the machine, being cut off at the rate of approximately 80 per minute in lengths of a few inches, the filament coils pass through two funnel-shaped contacts insulated from each other. These contacts are connected in series with a 2,000-ohm resistor which is in shunt with the 0.5 μf condenser that controls the electron-tube device.

If for any reason the machine fails to produce a filament coil within the pre-set time, the voltage across the condenser builds up to the critical value of the tube and trips a relay, stopping the machine. At the same time, an indicating lamp lights and attracts the attention of a supervising operator.

During the period these time-delay relays have been used as automatic stops on the mandrelless coil-making machines, shrinkage has been reduced approximately one-third. The resultant saving made it possible to write off the cost of the installation in six months.

Its economical operation, as a result of its cold cathode construction, and its characteristics of reliability and positive action make the WL-712 tube particularly suitable for any application of a time-delay relay, especially where resetting must be accomplished at high speed by electrical means and by delicate contacts. Its field of use, however, is not limited to time-delay devices only. It may be used for a variety of industrial applications to control a large output with a small input.

Audition panel at KFWB

A COMPLETE dial system for tuning in on programs of other broadcasting stations has been installed in the studios of Station KFWB, the Warner Brothers broadcasting station at Hollywood, Calif., and makes an added convenience for the program department in studying talent, conducting auditions, etc.

Four Philco standard sets and one all-wave set form the radio end of the panel and are normally all tuned to the principal five competitive local broadcast stations. Five additional channels are also provided, which can be connected with the stations own studios in which auditions are being conducted.

With the new panel system, which includes a special shielded antenna array supported by one of the main antenna towers, it is possible for the manager of KFWB to sit at his desk, and by operating a standard telephone dial, to select any of the stations which are permanently tuned in to the system, or to reach audition studios.

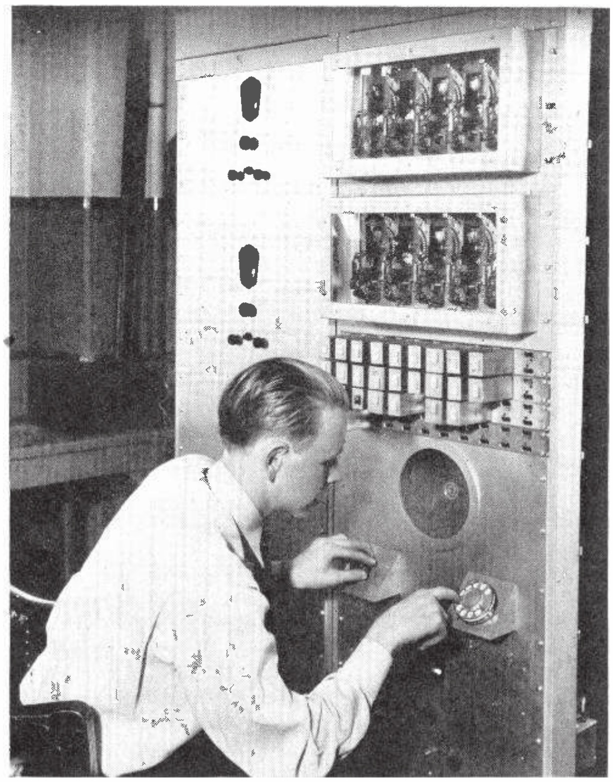
The set-up calls for the auto-telephone switchboard in ten different offices—each office equipped to listen to any five stations at separate times, or five different auditions —or all ten offices may listen to the same program or audition at the same time!

The dial is swung from the set number and as it swings back into position the main selector bank on the panel steps around and clicks into place and as the dial rests, the required station is heard!

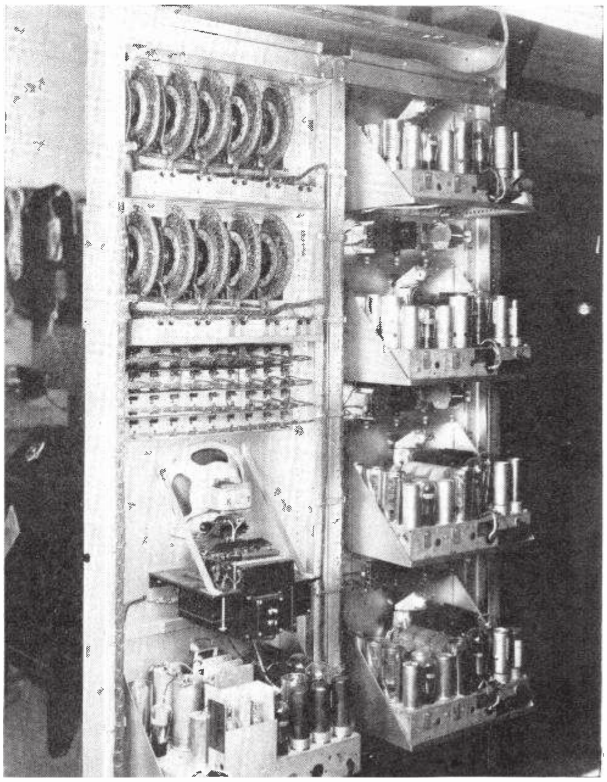
The selectors minimize the number of lines needed to each office. At the present four are used—where without the selector something like twenty would be necessary. The selector steps around to the number dialed by the user.

Such an "Audition Panel," according to Leslie Hewett, chief engineer, does away with a multitude of radio receivers—gives clearer reception in a shorter space of time and, allows the listener to choose any station or any audition which he cares to hear.

By means of a standard telephone dial, any station studio or any local broadcasting program can be instantly tuned in



Audition panel being operated from the monitor position. At left are panels for the various receiving sets



Rear view, showing main selector banks, relays, loudspeaker and standard receiving-set chasses employed

HIGH LIGHTS ON ELECTRONIC

Photo-cell engraving saves time at Detroit

The Detroit Times, one of the Hearst newspapers, is now making use of the photo-electric halftone engraver on its "rush" work. This machine, invented by Walter Howey of the Hearst organization at New York, was described and illustrated in *Electronics* for November, 1932.

The photo-electric engraver at Detroit gave an especially good account of itself during the recent earthquake disaster in California. Photographs of earthquake scenes were sent to Detroit over the telephone wires by facsimile. Within ten minutes of the time of receipt of photo-facsimile, regular two-column cuts were made and ready for printing.

Compared with this ten-minute service by the new photo-electric process, the ordinary time of making a similar cut by the standard half-tone process is forty-five minutes. The photo-cell thus registered a beat of thirty-five minutes over its fastest photographic rival.

✦

Photo-cell safeguards oil-burning power plant

The Procter & Gamble Company, Cincinnati manufacturers of Ivory Soap, Crisco, Chipso and similar products, had a problem which threatens every business using oil-burning boilers. Where the fire accidentally goes out in such boilers, the oil may flow over and is likely to cause an explosion when the flame resumes.

Procter & Gamble has provided against this contingency by the use of a Photronic cell mounted in a pipe, leading directly into the fire-box. The device is removed far enough from the furnace so as to keep it cool and prevent the cell from being damaged by the heat.

In case the fire goes out, the light fails. The cell then opens its sensitive relay which in turn opens a power relay. This de-energizes the starter coil, allowing the starter to drop to the stop position, which shuts down the blower motor and closes the electrically operated valve. In a jiffy the flow of oil to the burner is discontinued. Hence there is no danger of oil accumulating in the boiler and the likelihood of an explosion is prevented. All this takes place in a fraction of the time that it takes to tell it.

Usually the flow of oil into boilers is shut off by some sort of thermal relay, when the fire fails. But this particular photo-cell installation is more positive in its action than the usual fuel cut-off, for it is bound to shut off the fuel when the light goes out. The system operates unfailingly the instant the beam of light is interrupted.

Procter & Gamble put in this one installation as an experiment. They are so well pleased with the results that they are putting similar equipment in other plants.

✦

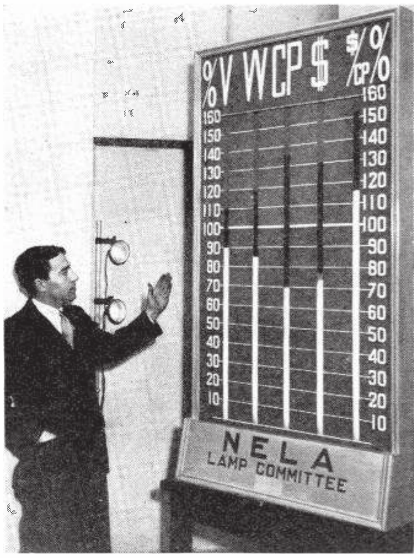
Photocell anemometer reads wind velocity directly

Clinton W. Hough, president of Wired Radio, Inc., New York City, makes use of a photocell to get a direct reading of the wind's velocity from the anemometer on his Riverside Drive apartment.

Ordinarily, in weather bureaus and other places where the familiar four-cupped anemometers are used, counters record the total rotations and then the speed of the wind must be calculated. To avoid this, Mr. Hough has arranged a photocell to be operated by a small lamp each time the anemometer shaft rotates. The pulsating current generated by the photocell is then amplified and carried to a coil-wound frequency meter, which is calibrated to read directly in miles per hour the speed of the wind.

✦

CHARTS CHANGE AT WAVE OF HAND



These charts co-relating lamp voltage, candlepower, costs, etc., can be manipulated to any set of inter-related values, by merely waving the hands, eclipsing a pair of photo-cells

Confidential voting with photocells

Dr. Nevil Monroe Hopkins, research and development engineer, 111 East 10th St., New York City, has developed a method for confidential voting by means of black and white disks held in the hands of the voters, while a photocell measures the total reflection of light from the white sides of the disks, signifying "yes". Dr. Hopkins has applied for patents on the method, which can be extended to infra-red light, so that the audience of voters sits in literal darkness and cannot see what each other's vote is. By measuring the output of the photocell with a meter, however, the percentage of voters holding up their disks with the white side front, can be quickly read off. The method is designed for secret voting in confidential canvasses, psychological tests, opinions, etc.

Before conducting the vote, the audience is first "balanced up" by measuring the light from faces, clothes, etc., for a zero line. Then a top reading for 100 per cent of white disks is made. Any percentage of "yes" votes will then be indicated by the position of the meter between these two points. Allowance is made for rows of voters further from the photocell by having them hold up larger disks.

✦

Perforated steel sheets pass sound waves

A novel method of acoustic treatment is being employed in the deadening of the dome of the new planetarium of the Franklin Institute at Philadelphia. This domed ceiling is the inside of a hemisphere 20 m. in diameter (about 65 ft.), on which are projected the images of the planets, stars, and other heavenly objects viewed by the audience. Yet while the dome must reflect optical images like a projection screen, it is also necessary that it reflect back no sounds of lecturer or audience—for such echoes with such a dome of ordinary materials would create a veritable whispering-gallery.

"Our problem was to simulate acoustically, the conditions of a hill-top under an open star-lit sky," explains James Stokley, director of the new Philadelphia planetarium. "Such a hill-top would be acoustically absolutely dead, since the sound would be absorbed in every direction by the open air."

Dr. Paul E. Sabine and Dr. Dayton C. Miller were consultants on the sound-treatment of the dome, and the surface now being installed comprises eight-foot sections of Allegheny metal, perforated

DEVICES IN INDUSTRY + +

with one-sixteenth inch holes, one-eighth inch apart. The metal plates (18 per cent chromium, 8 per cent nickel,) are shaped to the curvature of the dome surface, and are then "shot-welded" in place while being held on a special steel-arm form, pivoted at the center of curvature. Adjustable bolts hold the steel dome to the building framework. All wall surfaces above and behind the dome are also treated with a sound-proofing consisting of mineral-wool pads, one inch thick. The Allegheny-metal surface will be painted with a special white pigment, to secure maximum light reflecting power, while the sound-waves will pass unimpeded through the myriad of small holes.

◆

Music controls fountains in changing colors

SINGING COLOR FOUNTAINS controlled by strains of music which automatically regulates the flow of water and bathes each jet in colored light of changing hues corresponding to the rhythm, the mood and the tonal volume of the music, have been developed by the RCA Victor laboratories and put into operation for the first time at the Firestone exhibit at the Chicago World's Fair.

Vacuum tube relays in a "link circuit" change the electrical impulses produced by sound, into light or mechanical motion. By this means, the tonal frequencies are separated electrically into groups so that each will automatically correspond to a given color combination. The Singing Color Fountain utilizes the same fundamental principles as the automatic "color organ" developed by the same laboratories in Camden, N. J., which translates music into terms of colored light that may be projected on the walls of an auditorium in changing patterns. This color organ is also to be seen at the Chicago Fair in the RCA-Victor exhibit in Radio Hall.

The Firestone exhibit includes six fountains situated in a 100-foot pool of water, surrounded by terraced walks. Each jet is capable of spurting water to a height of 20 feet. Powerful colored light projectors hidden near the surface of the pool are automatically operated and controlled by the music, which also controls the water pressure of each fountain. As the music swells to a crescendo of volume and power, the colored hues reflected on the fountain deepen and the water wells up to its highest projection. When the music is light and airy, the fountain jets seem to dance in time with the music and the colors reflected on the moving water columns melt in and out in changing patterns of light. Similarly, the voice of a soloist or of a chorus can produce the same effects. Colors are known to influence definite emotional reactions. Thus it is known that green is restful, blue is cold, and that orange and red are warm and passionate.

◆

Photocell effects large savings in demand charges

A PHOTO-CELL UNIT has been applied by the Electric Power Construction Company, 201 North Broad Street, Philadelphia, Pa., to make any stylus-type curve-drawing electric or steam meter operate as a maximum-demand limitor or controller.

Light reflected from the polished stylus on the curve-drawing meter serves to operate the photo-cell which may in turn control a relay or switch for performing any function, such as merely giving a visual or audible warning, or actually interrupting part or all of the circuit. By means of a time-delay device, the maximum-demand feature can be limited to peaks which continue for a predetermined period. Where the unit is arranged to interrupt some circuit which can be turned off temporarily without inconvenience, savings in the demand charge as high as 10 to 25 per cent are not unusual, according to the makers.

Radio invaluable in forest-fire fighting

R. D. WATERHOUSE, electrical engineer of the U. S. National Park Service, Rainier National Park, Longmire, Wash., has applied short-wave radio for communication between forest patrols and between crews engaged in forest fire fighting. Two sizes of radio transmitters are used for this purpose.

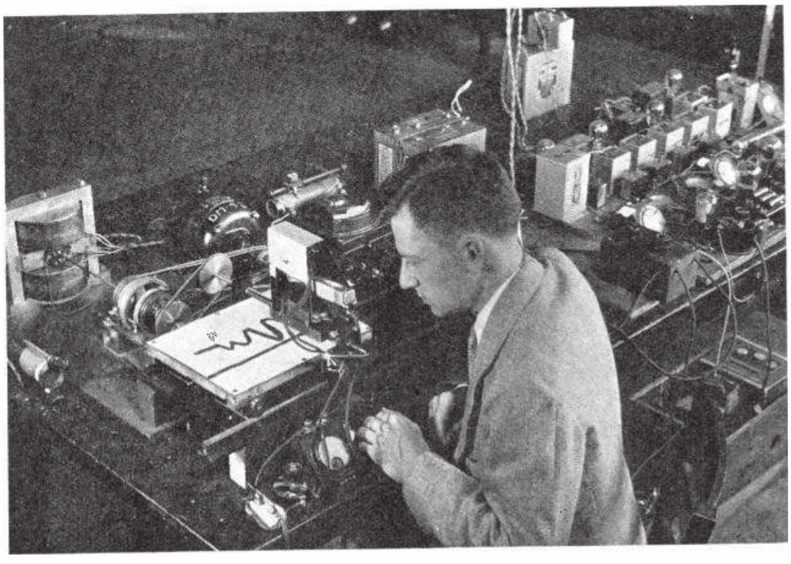
The larger of these two sets weighs about 60 lb. and has a voice range of 50 to 60 miles daytime (code much farther). This is a sort of field-headquarters set, which is moved about on truck or pack horse.

The smaller set is designed to be carried conveniently in a pack-sack, and hence goes right up onto the firing line wherever a man can go. This set has a range of 3 to 5 miles for voice and, of course, much more by code. Its function is to keep the front-line trenches in communication with the larger set on the truck, which, in turn, reaches to the outer world.

The purpose of this equipment, of course, is for maintaining constant communication in combating forest fires. The combination of these two sets makes it possible for the forest supervisor or the fire-crew foreman to plunge into the wilderness, go hurriedly through the roughest country, and still never be out of touch with the supporting lines.

◆ ◆ ◆

PHOTO-CELL STEERS FROM PRINTED GRAPH



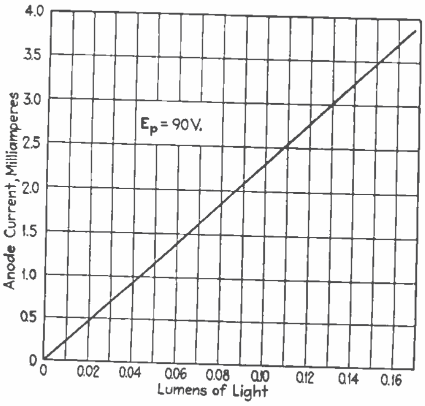
A plane or ship might be steered across the Atlantic on a great-circle course, automatically, by this photo-electric servo-mechanism developed at Massachusetts Institute of Technology, Cambridge, as an outgrowth of photo-cell calculating machines. Response occurs in one-twentieth second

+ + ELECTRONIC NOTES

Combined photo and amplifier tubes

By H. A. McIlvaine*

In an article appearing in December, 1932, *Electronics,* by Mr. Koechel, it was stated that the grid of ordinary vacuum amplifier tubes was light sensitive and that tubes of the conventional type could be made to pass current when illuminated by light. The writer has done much work for a number of years on this phenomenon and especially with combinations of photo-tubes with vacuum tube amplifiers in the same envelope.



In a typical circuit the light sensitive cathode and the triode anode are at opposite ends of a voltage divider with the grid and filament between these voltages, the grid being negative with respect to the triode cathode. In this case when the light sensitive cathode closes electrons they go to the grid and decrease its voltage, causing plate current change of appreciable proportions.

In the figure is shown the result of plotting anode current against illumination for a particular tube showing it to be linear and since it is a vacuum cell good at the higher frequencies. The combination of cell and tube has made possible loudspeaker operation from a modulated light beam without the medium of intervening amplification.

The writer has filed in the Patent Office a number of applications on various phases of this work; many of these applications are of several years' standing; several of them have been issued. It seems that there are many possibilities of useful combinations in this direction.

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*Continental Electric Company.

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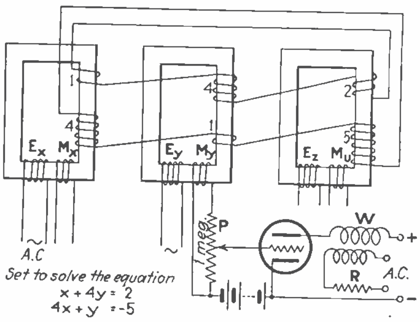
Vacuum tubes and calculating machines

In the determination of secondary stresses in bridges, sets of linear equations involving from ten to twenty unknowns may occur, and the labor involved in the solution of the otherwise simple system of equations becomes very great. To solve the equations $a_1X + b_1y + N_1 = 0$ and $a_2X + b_2y + N_2 = 0$—R. R. M. Mallock (Cambridge Instrument Company) uses three a-c transformers X, Y, N provided with the coils a_1, b_1 and N_1 respectively, with the end of N_1 directly connected to a_1, and carrying a second set of coils a_2, b_2 and N_2. If alternating voltage is applied to an independent coil E on the transformer X, the current flowing in the coil will induce a flux in the core of X, hence e.m.f.'s in all the other coils and fluxes and e.m.f.'s x, y, u on the other transformers. If the e.m.f.'s induced in the set of independent coils S_x, S_y, S_n are measured the ratio x/u, y/u, are the solutions of the equations. The reading instrument consists of a wattmeter W with vacuum tube, and the instrument constructed contains 10 coils and transformers. Proceedings Royal Society 140:457-484, 1933 has the description of this work.



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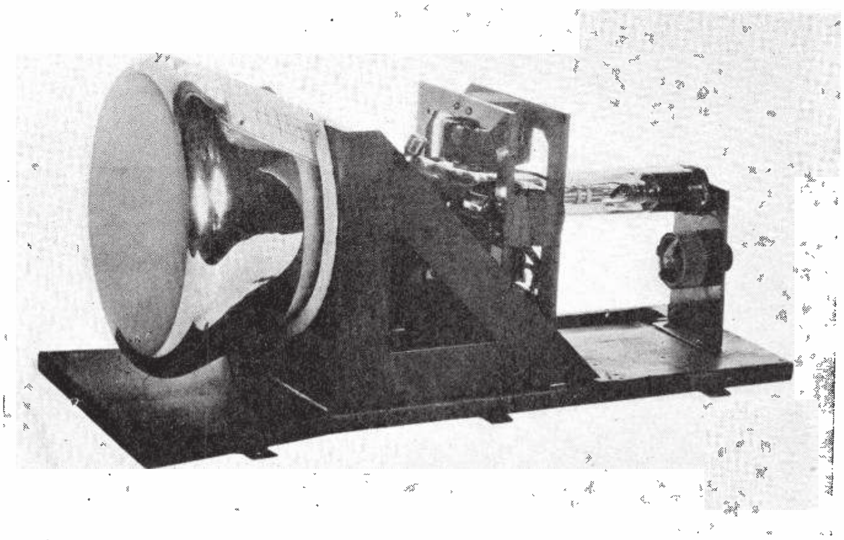
THE ICONOSCOPE



Cathode-ray scanning tube of Zworykin. The scene, focussed upon a mosaic of photocells, charges thousands of condensers whose discharge currents, produced by the cathode-ray beam, are transmitted to the receiver where the scene is re-created

The Lucerne plan

The wavelength distribution coming into effect in Europe and the Mediterranean countries on January 15, 1934, provides for 11 channels between 1,875 and 1,107 m. divided among 17 stations. In the band between 200 and 1,000 m. 53 channels used by 86 stations are above 300 m. and 53 channels used by 87 stations are below 300 m. Four cleared long wave and four exclusive medium wave channels are given to Russia, four medium waves to France, Germany has one long wave of its own and 11 medium waves, Italy four medium waves, Great Britain one long wave, two medium waves and one national wave (203.5 m.)

The power of stations having waves above 1,000 m. will be limited to 150 kw. (with the exception of Moscow); between 550 and 273 m. not more than 100 kw. are permitted (excepting Budapest, Leipzig, Prague, Rennes, Toulouse, Vienna, 120 kw. each). Between 273 and 240 the maximum permissible is 60 kw. and between 240 and 200 30 kw. The plan has resulted in shared wavelengths for a number of stations.—*Wireless World,* June 23, 1933.

FROM THE LABORATORY ++

Orientation mechanism

By A. L. Rubenstein

The design of a mechanism which automatically directs itself at a moving light source was first achieved by Mr. B. F. Miessner during the World War. Its practical applications were investigated at that time—and its limitations were principally due to the inadequate development of photo cells and accessory equipment. This inadequacy no longer exists, and this article describes an orientation mechanism which attempts to take advantage of more recent developments in electronics.

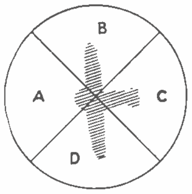


Fig. 1

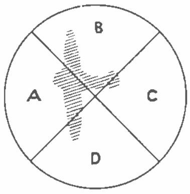


Fig. 2

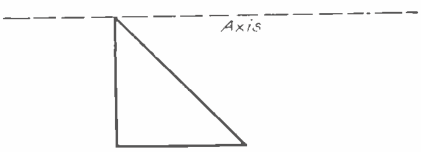


Fig. 4

In general, the device should maintain a line of sight between itself and some external object or light source in motion relative to the device. Successful operation in different fields will require some special adaptation. For example, the tracking of a lighthouse or lightship from a vessel at sea may be more easily accomplished than the automatic training of an airplane machine-gun on an enemy airplane. Conditions of poor visibility may require the operation of the device with infra-red sensitivity. The installation of the mechanism on a torpedo which shall follow its target, must necessarily be rugged and positive. In celestial photography where the telescope is moved by clockwork or more recently by a synchronous motor, automatic orientation may replace the present necessity for occasional slight manual correction of the field.

It is evident that we need an optical-electrical-mechanical sequence, with image position as the variable in the optical function. Image position is secured by a division of the optical field into segments. Image position variation is then completely expressed by the coordinates of light quantity variation in the segments. Orientation involves a return to the initial image position by maintaining a relative constancy of light in the optical segments. Figure 1 shows the initial position of the image in such a field, while Figure 2 shows some new position which is to be restored to the initial position of Figure 1. Assuming that the image is that of a dark object with a light background, it appears from the figures that movement of the object has resulted in a decrease of light in quadrants A and B. Assuming here that the decrease of light in one quadrant results in the motion of the optical field in the direction of that quadrant with respect to the center of the optical field, the net effect is the restoration of the image to the initial position.

Figure 3 illustrates an actual form of the complete device. An image of the object or light source to be tracked is focussed at the front plane surface of a circular glass prism the geometrical form of which is developed by the rotation of a right-angled isosceles triangle round the axis shown in Figure 4. Light from the image is thus reflected into planes approximately at right angles to the optical axis of the objective lens. The periphery of the cylindrical prism is divided into four quadrants, the light from each quadrant falling on a photoelectric cell. The extent of the field is limited to the region immediately surrounding the object by an adjustable diaphragm.

In the case of a light object on a dark background or a light source or point source of light, the photoelectric cell circuit for each quadrant is actuated by an increase of light in the corresponding quadrant. In the case of a dark object on a light background the circuits are actuated by a decrease of light in the corresponding quadrants. A single switch effects the transfer between the two types of image. The switch positions corresponding to dark and light objects (relative to background) are indicated at the switch by DO and LO respectively. Motion of the image relative to the optical device actuates the photoelectric cell circuits corresponding to one quadrant or to two adjacent quadrants. The circuit corresponding to a quadrant operates a mechanism—in this case a relay which brings a pulley into contact with a continuously rotating drum—which in turn moves the optical device to restore the quadrant concerned to its initial position with respect to the image. Use is made here of a grid-glow tube circuit—four complete circuits being provided, one for each optical quadrant. The variable condenser shown in the circuit adjusts the operating point of the grid-glow tube.

As an illustration of the use of the instrument for tracking a virtually point light source rather than an appreciably dimensional object, the point source of light is viewed through the eyepiece which is positioned to offer a virtual image of the plane of the front surface of the cylindrical prism; the latter being pierced by a small hole at the center. The optical device is then acting as a telescope with the circular prism acting as a diaphragm. Under these circumstances, practically no light from the point source is falling in any quadrant. Motion of the point source throws light into one quadrant or possibly two adjacent quadrants, actuating the corresponding mechanisms which restore the image to the central hole.

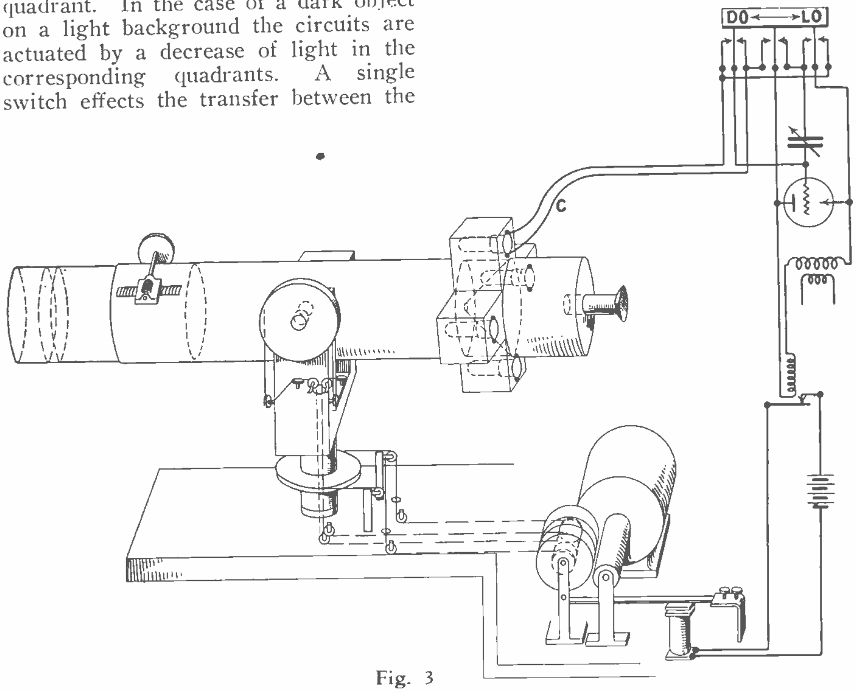


Fig. 3

electronics

McGraw-Hill Publishing Company, Inc.
330 West 42d Street
New York City

O. H. CALDWELL, *Editor*

Volume VI —AUGUST, 1933— Number 8

We may lose our shirt at Mexico City

THE North American Radio Conference is now going on at Mexico City.

Reports from the meeting indicate that Mexico's application alone called for sixteen clear channels, out of the present forty clear or near-clear channels. Also that if all of the requests from our neighboring nations were to be complied with, there would be just four channels left to the United States, on which to operate its 600 broadcast stations.

Very clear it is already, however, that out of this conference the United States is going to come away the loser, and that the pressure is going to fall on American clear-channel stations as the presumptive victims in a necessary new allocation.

The technical staff which accompanied the U. S. delegation is well-qualified. But unfortunately there is no one on the U. S. Committee itself who is personally equipped in a radio sense to grasp the situation and protect the interests of American broadcasting.

Radio sets will be smaller

UNDER demand from the automobile manufacturer for smaller radio sets for installation on future cars, tube engineers have gone into huddles to see what can be done. In this issue of *Electronics* will be found a description of the development of laboratory types of tubes directly aimed at very short wavelengths. The physical dimensions of these new tubes have been reduced by a factor of ten; but the electrical characteristics are as good as present standard sized tubes. This shows what can be done toward reducing tube size.

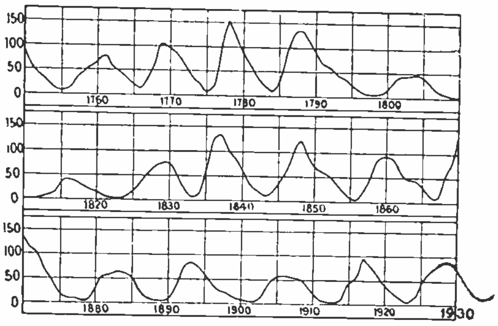
Fortunately the tube manufacturers have agreed not to turn loose on the market smaller tubes, especially made for auto radio, until the first of the year; there is no guarantee that new tubes will be available then. But it is certain that time will be provided in which the tubes may be thoroughly designed and tested.

In Germany a new core material containing iron is being used for interstage transformers, reducing the size of these components. In this country Polyiron seems to be winning more and more recruits. Iron core coils and iron core tuning will reduce the size of radio sets still further.

And so the tuning mechanism of radio sets is steadily being reduced in size. Time may come when the loud speaker must be separated from the tuner because the latter will be fitted into dimensions so small that not even a poor speaker could go into the space.

Forty centuries of sunspot cycles

RADIO reception is still showing the fading and distortion due to intensive reflection of the sky-wave from a Heaviside Layer undisturbed by sunspot activity. Long-range reception continues exceptional. We are again in such a period of sunspot minimum as we were back in the early days of broadcasting, when also a small station could be heard across the continent.



All over the world astronomers are watching for the breaking out of the first of the high-latitude spots on the sun which will indicate that another sunspot cycle is on its way. Each new 11-year cycle is ushered in by spots near the sun's poles, and these groups drift toward the equator as the cycle progresses.

But radio engineers who have waited patiently for an end of present broadcast distortion and fading, can find encouragement in the fact that the sun has been through a dozen such cycles recorded by human observers. And similar cycles stretch back through the centuries, as recorded by tree-rings.

Recently the editor of *Electronics,* strolling through the Egyptian rooms of the Metropolitan Museum of Art, New York, was confronted with unmistakable evidences of sunspot cycles recorded in the tree-rings of wooden caskets and statues, made of the cedar of Lebanon, and dating from 1900 B.C.!

For 40 centuries, evidently, the sun has been going through these same antics. Probably 350 complete cycles have taken place since those cedars of Lebanon set down their record. So there is every probability that the sun will come safely out of this present cycle and that radio will soon be itself again.

Why not a signal bell to call the radio listener?

EACH day striking news events are inserted into the broadcast programs, changing the routine schedules. Yet unless the listener has his own radio set continuously tuned in, he misses these most thrilling features of the radio day.

Every telephone is provided with a bell to attract the user's attention. Without a bell, a telephone would be only 50 per cent as useful.

Yet the average radio receiver is like a telephone without a bell.

The listener misses some of the best things on the air because he has no way of being notified. If there were some way of calling him to his radio set by means of a bell or a signal light, he would be able to enjoy special features. And so the public's appreciation of broadcasting generally would go up.

A low-frequency control tone on the station's carrier-wave, inaudible to the ear, but capable of operating a signal relay, might be one way to do the job. Clock control for special periods would be another solution. Radio engineers can suggest other ways so that the home or office radio set will ring a bell or light a lamp when a special announcement or superlative feature is on. Such a service would help popularize radio and bring the public to realize more fully the wonderful things the broadcasters provide.

H. D. Arnold, 1883-1933

THE loss of H. D. Arnold, director of research of the Bell Telephone Laboratories is a loss to science and engineering, and particularly to the arts with which users of electron tubes are familiar. Dr. Arnold had contributed materially to the general fields of communication, thermionics, and magnetism. In particular his early recognition of the necessity for high vacuum in amplifier tubes, his development of oxide-coated cathodes, his contributions in magnetic alloys have advanced to a high state the arts of wire, cable and space telephone and telegraph, phonograph recording and reproduction, sound motion pictures, improving the hearing of the partially deaf, and finally the newer art of electronics.

BEAT THE ELECTRIC EYE — MAKE $20

At the Chicago World's Fair, the Westinghouse company has a photo-cell protecting a $20 bill lying in apparent easy reach behind this bank-window. But when your hand goes in, a barrier goes up!

REVIEW OF ELECTRONIC LITERATURE
HERE AND ABROAD

List of French vacuum tubes

In connection with a discussion of recent French radio shows, lists of French vacuum tubes (60 triodes, manufactured by Dario, Fotos, Metal, Philips, S.I.F., Tungsram, Visseaux, about 15 r.f. tetrodes and pentodes, and as many a.f. tubes is given, adding perhaps for the first time in a foreign list the equivalent American designation). The characteristics of the tubes are all illustrated in a diagram. Then follows a list of 60 transmitting tubes for below 1,000 watts and as many tubes for above 1 kw., about 60 power rectifiers and ten mercury vapor rectifier tubes with incandescent cathode.—*Onde électrique* 12: 192-207, 1933.

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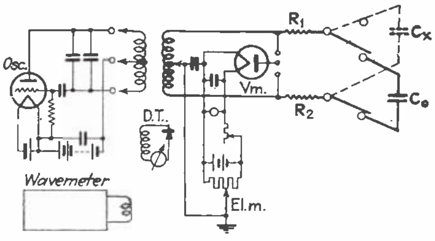
Phase defect measurements at frequencies above 1,000 kc.

[L. Rohde and H. Schlegelmilch. University of Jena] There are as yet few determinations of the loss angle at very high frequencies. A leaky condenser is considered to consist of an ideal condenser in series with a resistance R, the power consumed by the condenser being equal to $ei \cos (90 - d)$, where d is the phase defect angle and therefore, $\tan d = R \omega C$. The task is to deduce R with the aid of a calorimeter, or by comparison with the damping produced in an oscillating circuit containing a supposedly ideal condenser. A two-electrode tube voltmeter, with the cathode reduced to a single point measures the voltage across half the coil (so as not to add capacity across the condenser leads without introducing asymmetry). The potential induced by a neighboring oscillator, of the order of 10 volts, is measured by an electrometer, the resonance point being ascertained by means of a separate detector circuit *DT*. Quartz crystals are found to have the smallest loss, smaller than 0.0002, constant between 6 m. and 500 m., but they are closely followed by certain magnesium silicates (which have, however, a somewhat higher dielectric constant). Steatite gives $\tan d = 0.02$. The $\tan d$ of porcelain falls from 0.008 at 3,000 m. to 0.005 at 250 m. and increases below this value, owing to the presence of the armatures.—*El. Techn. Zeits.* 54: 580-584, 1933.



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List of German vacuum tubes for 1933

[E. Schwandt] Two firms only manufacture tubes for radio receivers, Telefunken and Valvo. The somewhat high prices being the same, but not the designations; thus the common screen grid tube is RES 094 for Telefunken and H 406D for Valvo. The choice offered differs appreciably from the American list as presented in *Electronics* for October, 1932. There is a relatively large number of tubes for battery operation (25 types), with thoriated filaments having passed out of the picture. Then there are about 20 different indirectly heated tubes for a.c. and 7 for d.c. (all with 20 volts on the filament which draws 0.18 amp.) There is one pentode in each of the two groups. There are several firms marketing each about a dozen different rectifier tubes. The glow discharge rectifier tends to disappear. In one type of the power rectifiers EG 50, EH 100, VG 45, NG 40 filament as well as plate connected without transformers to the a-c supply. A peculiar feature is presented by the various types of multiple tubes with built-in coupling devices requiring a special base with 6 to 9 prongs. A new filament has been developed in which wire and insulator are twisted as a whole to reduce noise (H 4080 D, H4125 D). *Funkt. Monatsh.* 2: 121-128. 1933.

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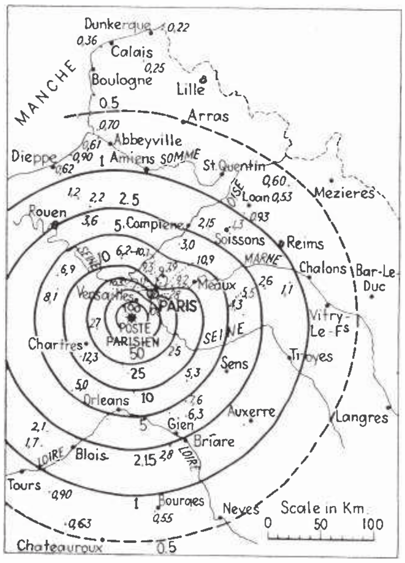
Field strength measurements

[P. David, chief engineer, National Radio Laboratory, Paris] The portable measuring device used by the French radio service consists of filter, local oscillator for calibration purposes, attenuator containing three transformers to a sinusoidal law, frame aerial with midpoint grounded and receiver. The combination of loop and sinusoidal transformer renders the calibration independent of the wage-length and the loop resistance. The intensities produced by the Poste Parisien (329 m.) and the Radio-Paris (1725 m.) have been measured throughout the country at distances up to 350 miles. The results obtained during the day agree with curves given by the Committee of Experts at the Madrid Conference. Measurements made in February, March and April, 1933, between Paris and New York, however, on Daventry (1554 m.) and Radio-Paris (1725 m.) are lower than the values given by Austin's formula, but beyond 1,000 miles four to six times higher than those indicated by the Committee of Experts. The night values obtained in France are also higher than those given by the committee.—*Revue gen. El.* 33: 623-620. 1933.



Field strength map of Poste Parisien

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Resonant circuit selectivity index

[H. Kafka] For series resonance circuits, in which L, C and R are approximately constant near resonance, whereas the frequency, but not the potential of the source varies, we calculate the expression $\tan a$ equals $(1/e - e)\ \omega\ L/R$, where e is the ratio $\omega/\omega_{res.} = f/f\omega_{res.}$ and a the phase angle. In the neighborhood of the resonance point, the slope of the tangent to the curve representing $\tan a$ as a function of e is equal to $-2\omega_r\ L/R$, and the index of selectivity is defined as $S_f = 0/02\ \omega_r\ L/R$. It corresponds to a change of 1 per cent in c. For a circuit containing a coil of 200 μh tuned to 500 kc. ($R = 5$ ohms), the index is 2.51; at 100 kc. it is 1.75 ($R = 11.6$ ohms) and when tuned to 1500 kc. ($R = 27.5$ ohms) it is 0.547 showing that the rate of drop when f is increased by 5000 cycles increases as the carrier frequency increases. — *Hochfr. u. El. AK.* 41: 176-184, 1933.

Soil properties at radio frequencies

[R. L. SMITH, Nat. Phys. Laboratory; see also M. J. O. STRUTT, Philips Research Lab. Eindhoven]. The change in reactance of a vacum tube oscillating circuit is determined when it is coupled to another or measuring circuit which contains the sample under investigation. The coil of the oscillator is coupled to that of the measuring circuit and as the conductivity in this circuit is adjusted, the reactance of the oscillating circuit, and the frequency change. The conductivities vary from less than 10^5 e.s.u. for dry soil to a value of several times 10^8 e.s.u. for normal moisture content, the corresponding dielectric constant from 2 to 3 to about 20, measured at the higher radio frequencies (the entire range being 1,000 cycles to 10 million cycles). The results indicate that at Rugby over 90 per cent of the ground current is carried within the first five feet of soil (10^7 cycles). For soil of 10^8 e.s.u. and 20 as dielectric constant the current will have decreased to 1/10 of the amplitude which it has at the surface at depth of about 5, 12 and 25 m. for 10,000; 1,000 and 200 kc. (30 m., 300 m., 1,500 m.)—*Proc. Roy. Soc.* 140: 359-377, 1933. *Annalen d. Physik* 17: 376-384, 1933.

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The influence of load on gain and selectivity

[H. G. BAERWALD, Heinrich Hertz Institute] When the load is a pure resistance equal to the internal resistance, we speak of matching; when inductance and capacity are present and the conjugate complex quantity of the load can be made equal to the internal resistance, we speak of resonance and have maximum output. It is shown how difficulties in matching account for the poor results obtained with feed back detectors. When several r-f stages are used, gain is a byproduct and selectivity is what counts, that is the width of the band in which the strength falls from 100 to 50 per cent (width y_{50}) and from 100 to 1 per cent (width y_{100}) and the approach to a rectangular top of the band, ratio g. The first case examined is that of a tube followed by a band pass filter in which the coupling of the resonance circuits varies only slowly with frequency. The treatment is then extended to "n," possibly staggered, circuits giving a symmetrical resonance curve. Staggering increases the width at the top. Without staggering it is useless to go beyond four stages as the ratio g increases only slowly above $g = 0.22$. With staggered and individually matched circuits g would increase with the number of stages to about $g = 0.6$ for ten stages.—*El. Nachr. Techn.* 10: 258-276, 1933.

Metal rectifiers for intermediate r.f.

THE WESTINGHOUSE BRAKE AND SAXBY SIGNALLING COMPANY, London, has developed the Westector, intended for the rectification of h.f. currents. In size it resembles a grid leak, and is a metal detector which can replace a diode tube in the detection without amplification of i.f. in a superhet receiver. In this case, it may be preceded by an ordinary screen grid or variable—mu r.f. amplifier, but at r.f. a low impedance high mutual conductance screen grid tube is recommended.—*Electrician* 110: 489. (April 14) 1933.

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Conductivity of cuprous and cupric oxide

[M. LEBLANC, H. SACHSE and H. SCHOPEL, University of Leipzig; F. ROTHER and H. BOMBKE, University of Berlin]. The conductivity of cuprous oxide Cu_2O depends a great deal upon its purity; when it contains oxygen, or traces of pure copper, the value increases. It varies in general between 3.6 x 10^{-9} and 6.6 x 10^{-9} in the compact form, and between 4.7 x 10^{-9} and 3 x 10^{-9} in powdered form. Cuprix oxide CuO conducts about one thousand times better.

It is found that when sheets of copper are left at about 1,065° C. for nine hours instead of the usual much shorter period used when preparing photocells, the cuprous oxide migrates from the surface into the pure copper. The layer thus formed is conducting where it neighbors the pure copper, and gives no photo-effect; near the surface we have pure cuprous oxide; the photoelectric effect is produced in the cuprous oxide; but the electrons cannot traverse the boundary layer of pure cuprous oxide between the mixture of copper and cuprous oxide and the mixture of cuprous and cupric oxide near the surface. — *Ann. de Physik,* 17:334-344. 1933. *Zeits f. Physik* 81: 771-775. 1933.

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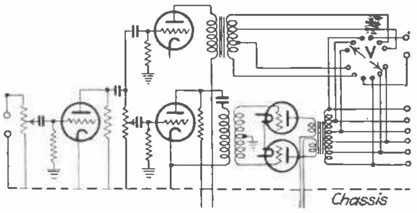
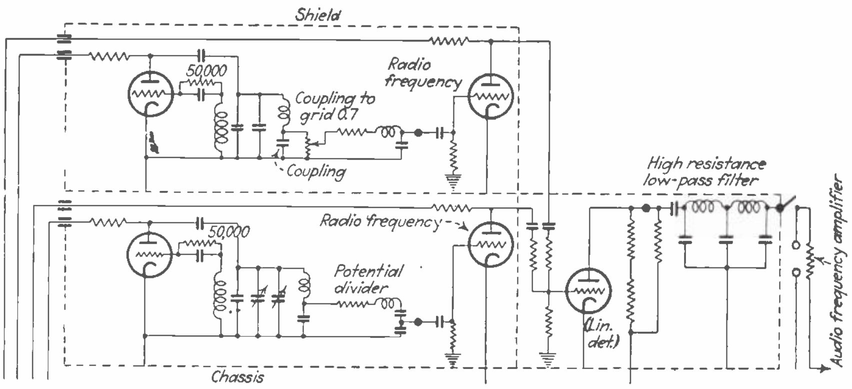
Improved beat frequency oscillator

[R. V. RADINGER, Heinrich Hertz Institute, Berlin.] Both oscillators are built alike as much as possible and the stray field of the grid coil is reduced to a low value by choosing a small value of L/C. Not only were the coils screened, but special condensers with a small temperature coefficient used, and the tubes so arranged that their heat was dissipated without heating the rest of the set-up. As the coupling must not change over the required frequency range, it is made close for each oscillator so that overtones appear; their strength is kept low by small L/C and coupling the r-f amplifier in such a way to the oscillator that the higher frequencies are damped out. The more one r-f oscillator exceeds the other in strength near the detector, the smaller the percentage strength of the overtones. Distortions in the audio stage are minimized by giving generous dimensions to the core and by using push-pull output. R-f currents were prevented from entering the audio stages by a filter having a high input resistance. The audio frequency amplifier is straight from 10 to 10,000 cycles as long as there is no load, but the output drops rapidly at the higher frequencies when loaded, so that the device was designed to give two ranges, 0 to 750, and 750 to 10,000 cycles. Above 100 cycles the strength of the overtones was 0.5 per cent at one watt, the frequency variation 0.3 cycles within an hour.—*Zeits. techn. Phys.* 14: 197-202, 1933.





Circuit of beat-frequency oscillator of Radinger

Higher voltage vacuum tubes—faster electrons

[*Continued from page 217*]

down the foundations of the atom, is the "neutron mill" designed by Dr. Crane and Dr. Soltan under the direction of Dr. Charles C. Lauritson. For this "neutron-factory," the raw materials are electrons, helium gas, berylium, lead and paraffin. With an ultimate intensity of more than 1,000,000 volts, electric particles are shot through the helium, knocking off electrons surrounding the helium atom, which then becomes an artificial alpha particle. The next stage in the process consists in using the alpha particles as ammunition with which to blast neutrons out of the berylium. Next to cosmic rays, neutrons have the greatest penetrative power of any ultra microscopic entity. Whereas a 1,000,000-volt X-ray penetrates less than an inch of lead, it has been found that the neutron penetrates more than four inches of lead. After passing through a lead plate of that thickness, neutrons obtained at Caltech shoot through a cake of paraffin, knocking off particles from the paraffin atoms. A supersensitive electroscope reveals the presence of the new-born neutrons by registering the degree of activity of the particles they smash from the paraffin atoms.

Results to be accomplished by the great high-voltage X-ray tube constructed by the Massachusetts Institute of Technology to be driven by the 10,000,000-volt Van de Graff static machine at South Dartmouth, Mass., were outlined by Dr. Karl Compton, president of M. I. T., speaking before the convention of the Association for the Advancement of Science at Chicago.

So far on preliminary tests the huge Van de Graff machine has delivered only 6,000,000 volts of its expected 10,000,000 volts, but the trouble has been traced to the stealing of electrostatic charge by the metal walls of the great hangar in which the static machine is housed. These walls are now being insulated, said Dr. Compton, and in September "Goliath" (as the great generator is nicknamed), will be ready for test with the great X-ray tube now nearing completion at Cambridge by Dr. Van de Graff, L. C. Van Atta, and E. W. Samson. For this tube, it was found that glass would not withstand the terrific electrical strains imposed by the high voltage on which the tube is to operate, so the designers had to resort to other materials.

The velocities which the electrons will attain in this great tube under the 10,000,000-volt potential of the electro-static generator, are comparable to those of the cosmic-ray particles themselves, so that the M. I. T. tube is in effect a "cosmic-ray tube." At 10,000,000 volts the electron penetration will be two and a half times as great as the penetration of the gamma rays of radium, which have energies corresponding only to about 4,000,000 volts. Beyond the spectrum of the gamma rays lies the enormous range of the cosmic rays, which reach up to three billion volts, so that the new tube will mark the entry of man's experiments into the cosmic-ray field.

Thus science will have reached a new landmark, commented the speaker, creating artificially for the first time electron velocities comparable to those coming from interstellar space, and designated by Dr. Millikan as the birth-cries of matter, when heavy atoms are built up from lighter ones.

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NRA Radio Industry Code

[*Continued from page 208*]

by the firm of public accountants. Upon complaint that a manufacturer has sold below cost, the National Committee may upon its own motion have the books of the suspected manufacturer investigated and audited, and if the audit discloses that sales were made actually below cost of production, the National Committee is required to report all facts to the National Recovery Administration.

Dropped lines or surplus stocks which it is necessary to convert into cash, must be first reported to the executive committee of the radio-set division, and its approval obtained before proceeding with the sale.

Each manufacturer is permitted without restraint or restriction whatever, to determine the amount and character of the radio products which he produces.

Nothing in the Code applies to radio and television sets sold for export and actually exported and retained in foreign countries.

Chapter II, relating to radio-tube manufacturers, stipulates that the provisions in the main Code referring to cost-of-production shall not be applicable to manufacturers of radio tubes, except as outlined in the tube chapter. Also, the radio-tube manufacturing industry is defined to mean "the manufacture for sale of electronic tubes or valves." Section 6 of the tube chapter specifies that no tube manufacturer shall sell his tubes at terms or conditions that will result in the customer paying for the goods received less than the cost to the seller—provided, however, that dropped lines, seconds, or inventories which must be converted into cash to meet emergency needs may be sold on conditions approved by the National Emergency Committee—also further that selling below cost in order to meet existing competition on products of equivalent design, quality, character or specifications, shall not be deemed a violation of this section of the Code.

Where tubes are sold by price lists, new lists embodying revised prices must be filed with the executive committee ten days in advance of the change. The committee will then supply copies of the new prices to all known tube manufacturers, who are in turn privileged to file copies of their revised price lists and discount sheets which become effective with the date of the first price revision filed.

For a period of one year from the adoption of the Code, it is agreed that no new radio receiving tubes will be introduced, except for experimental purposes, without the approval of the executive committee of the tube division.

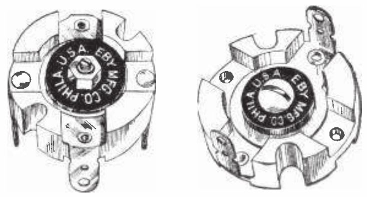
The Radio Industry Code was submitted to the National Recovery Administration for revision, on June 29. A public hearing will be held at which interested persons may express objections to provisions in the Code. Acting upon this evidence, revisions will be made, and the revised Code submitted to the President of the United States for his approval. When so approved by the President, the Code takes effect within ten days.

+ NEW PRODUCTS

THE MANUFACTURERS OFFER

Trimming condensers

The H. H. Eby Manufacturing Company, 21st and Hunting Park Ave., Philadelphia, Pa., announces a new line of trimming condensers. The featured number is the new trimming condenser in double form. As shown, this item is similar in its general aspects to the single trimmer. However, the double feature has some exceedingly novel aspects. For instance, a single assembly can be used in the intermediate frequency transformer and adjusted from one side for each condenser which is respectively connected to the primary and the secondary of the transformer to be tuned.



The assembly is easily and quickly mounted and is compactly designed. These new Eby trimming condensers are made of the highest grade ceramic material with a power factor of between 0.4 per cent and 0.5 per cent. The plates are of spring, non-ferous material. The single or double assembly can be made in any practical range that an engineer might require, the low range being 10—80μμf and the high range 700—1000μμf. — *Electronics, August, 1933.*

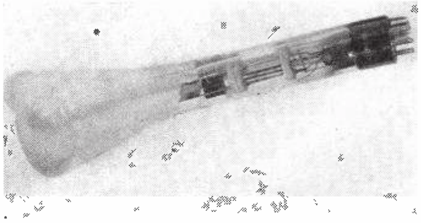
✦

Universal output meter adapter

A handy connector for oscillators and output meters, is offered by the Alden Manufacturing Company, 715 Center St., Brockton, Mass. The clip is so designed that it will contact the plate prong or any other small prong of any tube, whether it has 4, 5, 6 or 7 prongs on either the small or large sized base. It is also properly insulated for use in the closely shielded sockets. With all these valuable features it becomes a necessary adjunct to every output meter. So flexible is the design of this connector that it may also be used for attaching microphones, tone controls, pickups, extra speakers, amplifiers, volume controls, volt meters, etc. to the cathode, plate or various grid prongs of any tube.—*Electronics, August, 1933.*

Intermediate voltage cathode ray tube

The 342-G is a high vacuum tube of the heater-cathode type for use in studying wave forms of alternating currents at any frequency between zero and sixty million cycles. It is capable of reading voltages from one to one thousand volts without amplifier or voltage divider. The tube has a grid so that the intensity of the spot may be varied at any frequency between 1 and 100,000 cycles. The spot is focused electrostatically by two anodes. The size of the spot is one millimeter. The color of the spot is either green very nearly white or blue and is determined at the factory. The color of the tube purchased should be chosen by the purchaser in accordance with the use to which the tube is to be put. The life of the tube is rated conservatively at 300 hours. This tube is manufactured by the Telephoto Corporation, 135 W. 19th St., New York City, and retails at $30.



Characteristics

Cathode	2.5 volts 2.75 amps. (heater)
Anode A_1	½ anode voltage on A_2
Anode A_2	700 to 2,000 volts
Sensitivity	5% of A_2 potential to deflect beam one inch
Grid	–45 to –90 with respect to cathode
Frequency range.	deflecting plates 0-60 megacycles grid, 0-100 kilocycles

—*Electronics, August, 1933.*

✦

Sparks suppressor

A new suppressor for automobile radio sets has been developed by the Erie Resistor Corporation of Erie, Pa. Tests made by manufacturer on this suppressor have shown that it will not change more than 10 per cent in resistance value in 50,000 miles use, provided one suppressor is used in each high tension lead.

It is stated that an unusual "mix" has been perfected which stands up in the extremely short length used in this unit.—*Electronics, August, 1933.*

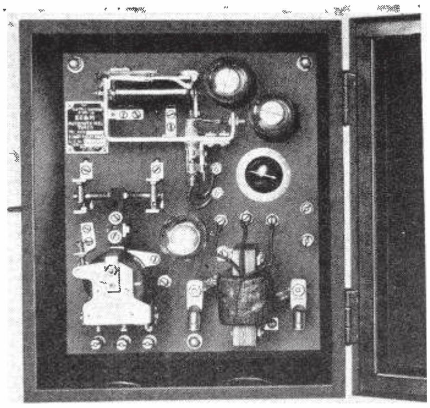
Paper condensers

The Solar Manufacturing Corporation, 599-601 Broadway, New York City, in addition to its line of electrolytic and mica condensers, is now manufacturing paper condensers in a new department recently installed for this purpose. This department is equipped with automatic winding and impregnating machinery designed to take care of both standard and special types of paper-dielectric condensers. The complete Solar line now covers all fixed condensers used in the radio and allied industries, including wet and dry electrolytic condensers, paper condensers, and molded mica condensers.—*Electronics, August, 1933.*

✦

Automatic weld timer

For use in connection with resistance welding machines, Electric Controller & Manufacturing Company, Cleveland, Ohio, announces an automatic weld timer. This timer does not provide a definite amount of time for each weld, but varies the time automatically in inverse proportion to the rate of current flow to produce a 100 per cent weld at each operation. The standard type of automatic weld timer consists of a rectifier tube which charges a fixed condenser in proportion to the rate of current flowing in the welding circuit. When the charge reaches an amount sufficient to pass current through two neon-gas-filled tubes a small relay is operated, which in turn opens the relay controlling the main line contactor. The tubes are in the circuit only when the welding current is on, so that as soon as the main welding circuit is opened the weld timer is ready for the next operation.—*Electronics, August, 1933.*



Fuse retainer for auto receivers

Developed to meet the demand of manufacturers of automobile and battery-operated sets for a fuse mounting that would not take up any additional space in the set and still be readily accessible for servicing and renewals. Littlefuse Laboratories, 1772 Wilson Ave., Chicago, Ill., are marketing their No. 1061 fuse retainer, which is hung directly in the line between the storage battery and the radio power supply. A tension spring at all times furnishes good contact to the fuse, which is fully protected by the fiber casing.—*Electronics, August, 1933.*

✦

Multi-range testing set

Ferranti, Inc., 130 West 42nd St., New York City, is marketing a multi-range testing set for making accurate measurements in both the laboratory and field. Designed for alternating-current use, this self-contained set consists of two long-scale moving iron instruments and may be used on direct current at a very slight reduction in accuracy. The set has a range from one-half volt to 600 volts, and will measure from 50 mils to 5 amperes.—*Electronics, August, 1933.*

✦

Station frequency meter

An ingenious method of comparing the frequency of a transmitter directly to the 5,000-kc Bureau of Standards transmission has been devised by the G. F. Lampkin Laboratories, Cincinnati, Ohio, and is offered in a single instrument. The accuracy of the calibrating signals, which can be heard over a large part of the world, is within one part in five million. The Lampkin device can be set and the frequency of the transmitter determined within an error of 0.003 per cent or less. The meter can be supplied for any channel from 1,500 to 23,000 kc.; employs a stable oscillator operating on an odd low frequency such that when one harmonic falls exactly on 5,000 kc., another harmonic falls within the range of the deviation dial on the meter. The price of the instrument is $105.—*Electronics, August, 1933.*

✦

Reactance meter

Premier Crystal Laboratories, Inc., 63 Park Row, New York City, have recently announced a new instrument for making rapid measurements of inductance and capacity. This instrument is known as model SA-165, and is provided for complete a.c. operation.

No external standards or apparatus of any type are required, except a pair of high impedance headphones. The instrument operates on the zero beat principle and by incorporating a new system of detection, it is possible to read values of inductance or capacity with an accuracy comparable to that obtained with a highgrade bridge setup. No false readings, due to improper grounds, are encountered, inasmuch as one side of the unknown is grounded to the entire system.

The range of the standard instruments is from 10μh to 1 henry for inductance and from 1$\mu\mu$f to 5μf for capacitance. For measurements of actual inductance and capacity, an accuracy of 1 per cent for full scale reading of each decade position is attainable and an accuracy of 2 per cent for minimum scale values. For matching inductances or capacities, an accuracy to within 0.17 per cent may be obtained.

The instrument is designed for operation on 60-cycle, single-phase, alternating current, and is provided with a panel indicating voltmeter and a line voltage regulating device, capable of compensating for any line voltage variation from 100 to 125 volts.

The instrument is priced at $275 complete with all tubes and calibration charts.—*Electronics, August, 1933.*

✦

Sound-effect transcriptions

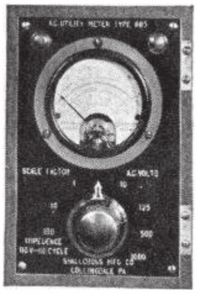
The Gennett Record Division of the Starr Piano Company, Richmond, Ind., now has available a very complete library of electrically-transcribed sound effects of all kinds, taken from life. There are hundreds of these 10-inch 78-r.p.m. records, and they include all standard sounds that might be wanted as features or background in a sound studio or broadcast station, as well as unusual effects such as the following, picked at random from the long list:

Animals in the zoo; automobile crashes; bacon frying; coffee percolating; blizzard; calliope; campfire; chimes; elephant trumpeting; milking cows; typewriters; rainfall; washing clothes; bowling alleys; fire engines at fire; shuffling and dealing cards; rattling poker chips; putting ice into pitcher; Indian dances, etc.—*Electronics, August, 1933.*

A-C utility meter

The Shallcross Manufacturing Company, 700 Parker Ave., Collingdale, Pa., has designed its alternating-current utility meter No. 685 to provide essential a.c. voltage measurements and a wide range of impedance measurements using the universally available 110-volt 60-cycle commercial power.

In order that this instrument will be of maximum value the impedance ranges are calibrated in inductance, capacity and resistance. As a result, it is possible to obtain any of the following voltage, capacity, inductance and resistance ranges.



A-C volts	10-125-500-1000 (1000 ohms per volt)
Resistance	25-50,000-500,000-5,000,000 ohms
Capacity	.0005 to .1-1-10 mfd.
Inductance	.5 to 100-1000-10,000 Henrys

—*Electronics, August, 1933.*

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Manufacturers' bulletins and catalogs

Electronic tubes — Transmitting tubes, radio, sound and industrial rectifiers, made by the Granger Manufacturing Company, 170-172 Bruce St., Newark, N. J., are described with full specifications in a bulletin just issued.

Rheostats and resistance units—Catalog No. 9 of the Ohmite Manufacturing Company, 636 North Albany Ave., Chicago, Ill., covers rheostats and resistance units of both fixed and variable types.

Rheostats and potentiometers — The DeJur-Amsco Corporation, 95 Morton St., New York City, describes its equipment for power control of sound and movie systems in a new specification sheet.

Midget relays—Bulletin No. 6 of the Ward Leonard Electric Company, Mount Vernon, N. Y., lists 130 midget magnetic relays, with circuit diagrams and contact arrangements.

Oiled tubing—Turbo insulating materials, varnished cloths, tapes and papers, oiled tubing and saturated sleeving, are described in Bulletin No. 10, of William A. Brand & Company, 268 Fourth Ave., New York City.

Sound equipment—Sound reproducing and sound-recording equipment made by Audio Research, Inc., 105 East 16th St., New York City, is the subject of a new bulletin by the company.

Organ-type sound systems—Organ-type sound reproducing systems for churches, schools, clubs and private homes, etc., are described in a booklet issued by RCA-Victor Company, Camden, N. J., special products division.

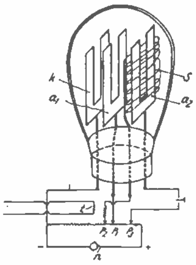
Tube data — The Arcturus Radio Tube Company, Newark, N. J., has issued a pamphlet of technical data covering its radio tubes, with complete characteristics.

Transmitting tubes, rectifiers—A complete catalog of the products of the Federal Telegraph Company, 200 Mount Pleasant Ave., Newark, N. J., covers its transmitting tubes, short-wave tubes, general-purpose tubes, rectifiers, and other electronic products.

U. S. PATENTS
IN THE FIELD OF ELECTRONICS

Amplification, Detection, Etc.

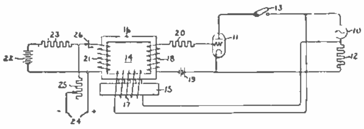
Cold cathode tube. Glow discharge tube for amplification, rectification or oscillation. Nos. 1,914,044 and 1,914,045 to George Seibt, Berlin, Germany.



Triple modulation system. A directive radio beacon using triple modulation. H. Diamond and F. G. Kear, assigned to the Government of the United States. No. 1,913,918.

Static suppressor. Method of using a conductor in the output of a set having normally high resistance and having a substantial reduction in resistance upon the application of voltage above a certain value. C. S. Wolfe, Norristown, Pa. No. 1,913,909.

Phase Shift Circuit. Use of an alternating potential with a self-saturating transformer in the secondary winding of which is induced a peaked wave form and a source of magneto-motive-force for determining the point in the cycle of alternating potential at which the resultant m.m.f. passes through zero and thus the phase of the secondary potential. B. D. Bedford, assigned to G. E. Co. No. 1,918,173.



Hum prevention. System for energizing a detector by a.c. on the filament and means for energizing the grid as a rectifier whereby disturbing hum production is avoided. B. F. Miessner, assigned to R.C.A. No. 1,917,728.

A.C.-D.C. system. Method of producing A.C. from a battery in an automotive system. W. J. Williams, Chicago, Ill. No. 1,917,565.

Radio circuits. Interstage coupling system. H. A. Wheeler, assigned to Hazeltine. No. 1,913,693. See also No. 1,913,604 to W. A. MacDonald.

Super-regenerative receiver. Circuit and receiver employing especially designed tube. L. Tonks, assigned to G. E. Co. No. 1,915,076.

Oscillator. An oscillator with several piezo-electric crystals of opposite temperature coefficient of frequency connected in the circuit for compensating the effect of temperature variations. F. R. Lack assigned to B. T. L., Inc. No. 1,915,368, filed Aug. 8, 1928.

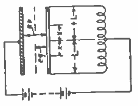
Amplifier. Method of utilizing a positive grid voltage-plate current region of the tube characteristic. Lincoln Thompson assigned to R.C.A., Inc. No. 1,915,629, filed Dec. 26, 1928.

Aircraft Compass. Combination of a directional absorber of radio energy having a figure-of-eight characteristic, an untuned non-directional absorber, and means for combining the signal energies from the two absorbers. G. R. Fisher, assigned to Federal Tel. Co. No. 1,915,274, filed May 26, 1930.

Harmonic reduction. In a vacuum tube, the combination of a grid electrode, a plate electrode, and a V-shaped electron-emissive cathode filament, said cathode filament having such resistance, normal heating current, and distance separating its ends, that the following formula is fulfilled

$$e_p + \mu e_g = \frac{1}{\sqrt{32 M \frac{8}{L^2}}}$$

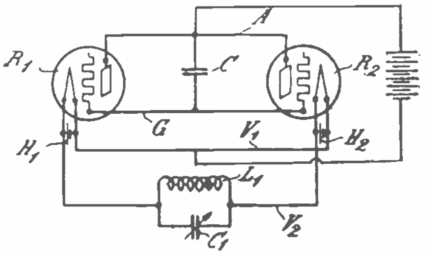
where e_p is plate electrode operating voltage and e_g is grid electrode operating voltage, where M is the decrease of the plate current due to the magnetic effect arising when one volt is impressed between ends of the cathode filament, K is the decrease of plate current due to attraction of electron to the positive end of the cathode filament when one volt is impressed between ends thereof and L is half the distance between the ends thereof. Lee Sutherlin, assigned to W. E. & M. Co. No. 1,916,446, filed Oct. 10, 1928.



Coupling arrangement. Method of including in the output circuit of an amplifier an inductance included in the cathode circuit. L. C. F. Horle, Newark, N. J. No. 1,917,204, filed Jan. 24, 1930.

Power amplifier. An amplifier using two tubes which have impressed upon them simultaneously the input voltage. The output circuits are arranged with respect to each other so that the currents in a common portion are superimposed on each other in such a way as to effect in a portion of the output circuit of the first tube a characteristic having on opposite sides of its operating point curves which are symmetrical but inversely disposed to each other. E. P. Bertram, assigned to B. T. L., Inc. No. 1,917,015, filed June 25, 1931.

Short-wave generator. Two tubes with plates and grids respectively in parallel but with an anti-resonant circuit in part of the common filament circuit. Abraham Esau, Jena, Germany. No. 1,917,105, filed July 25, 1929.



Automatic volume control. A radio system having an r-f amplifier, a power supply including a voltage divider with a poor regulation characteristic and provided with a detector to function over a large input voltage range and an avc system. H. M. Threlkeld, assigned to Grigsby-Grunow. No. 1,913,461.

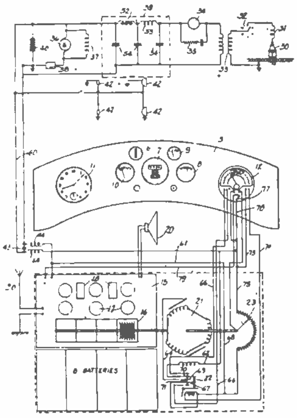
Diversity reception. Method of coupling several antennas and receivers to an i-f amplifier and detector. E. Bruce, assigned to B. T. L. No. 1,913,428.

Metal oxide rectifier. Radio circuits employing a metal oxide rectifier coupled to the output of an amplifier. W. P. Place, assigned to Union Switch & Signal Co. No. 1,917,898.

High-frequency generating system. A tube with coiled grid and plate electrodes each serving as open-ended inductances, and the circuit for high-frequency generation in which the two electrodes serve as the sole means for inductively coupling the input and output circuits of said device. A. B. DuMont, assigned to DeForest Radio. No. 1,915,356, filed Nov. 26, 1928.

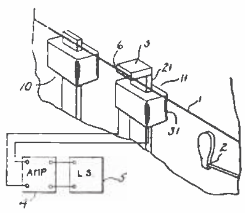
Elimination of fading. John Hayes Hammond, Jr. Nos. 1,915,782 to 1,915,786 inclusive.

Automobile radio. Means for excluding electrical oscillation surges from the electrical energy source for the conveyance comprising a r-f filter and an a-f filter, means for supplying energy to the receiver from the same electrical energy source as the conveyance, and means for controlling the receiver from a remote point. L. M. Clement, assigned to Brandes Laboratories. No. 1,915,290, filed Oct. 5, 1929.



Electron Tube Applications

Musical instruments. Methods of utilizing the vibration of a tuned string with a mechanico-electric transmitting device. B. F. Miessner, Millburn, N. J. Nos. 1,915,858 to 1,915,861 inclusive.



Sleet melting device. Method of using an antenna conductor consisting of a high electrical resistance core and an outer low-resistance shell for the purpose of removing sleet. L. C. F. Horle, Newark, N. J. No. 1,917,205, filed June 20, 1932.

Fiber treatment. Process for treating fibrous material by immersion in a vessel permeable to magnetic waves containing water having a slight electrical conductivity and placing the vessel in a high frequency field until the fats and oils are broken down and the fibers separated. Alfred Uhlmann, Berlin, Germany. No. 1,917,168, filed Jan. 18, 1928.

Frequency and phase indicator. Method involving the multiplication of the frequency of the unknown source and the frequency of a known source. Alfred Crossley, Washington, D. C. No. 1,916,782, filed June 11, 1928.

Regulator system. Method of controlling the excitation of an a-c generator by means of a copper-oxide rectifier operating on a non-linear portion of its resistance-voltage curve. J. H. Sole, B. T. L., Inc. No. 1,915,389, filed May 29, 1931.

Magnetic material. Method of producing a magnetic material in finely divided form comprising mixing a metal and an element in a desired proportion and heating said mixture at a temperature below the fusion point of the metal and the element and sufficiently high to effect the substantial diffusion of said element and metal. E. E. Schumacher and W. C. Ellis, Bell Telephone Laboratories, Inc. No. 1,915,386, filed April 16, 1932.

Statistical machine. Method of using photo-electric cells in a statistical machine. P. W. Handel assigned to G. E. Co. No. 1,915,993, filed April 27, 1931.

Direct-current commutator. Method of using three element tubes as a d-c commutating system. Erwin Kern, assigned to Brown Boveri. No. 1,915,790, filed May 30, 1929.

Tube tester. Testing device for electron tube circuits. John H. Miller, assigned to Jewell Elec. Inst. Co. No. 1,913,766.

Regulation control. Method using a three-element tube, a carbon pile, and saturated and unsaturated transformers. L. H. Von Ohlsen and F. W. Godsey, assigned to the Safety Car Heating & Lighting Co. No. 1,914,545. See also No. 1,917,474 and No. 1,917,473.

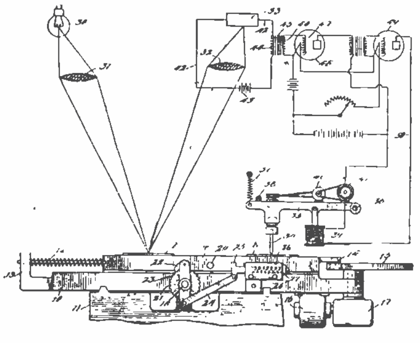
Elevator control. Method for using light sensitive devices and amplifier tubes for controlling an elevator. M. A. Whiting, assigned to G. E. Co. No. 1,915,042, filed Sept. 26, 1929.

Automatic dimming. Method of controlling the light of a vehicle when meeting an oncoming lighted vehicle by means of a selenium cell. Rudolph Loewenstein, Paris, France. No. 1,917,532.

Time delay circuit. Method of using a condenser and a gas-filled tube and a relay for electric delay circuits. M. L. Almquist and A. C. Thompson, assigned to A. T. & T. Co. No. 1,917,418.

Speed control. Method using tuning fork whose frequencies are slightly above and slightly below the normal value of a controlled frequency. H. W. Dreyer, assigned to R.C.A. No. 1,917,295.

Machine for producing printing plates. Method of scanning a picture, amplifying the scanning currents to operate a plate-cutting tool. Walter Howey, New York, N. Y., filed Oct. 19, 1929. No. 1,914,258.



Patent Suits

1,614,136, M. C. Latour, Thermionic amplifying apparatus, D. C., S. D. Calif. (Los Angeles), Doc. E Y-74-C, Latour Corp. v. Trans Continental Radio Co., Inc., et al. Decree for plaintiff Mar. 15, 1933.

1,173,079, E. F. Alexanderson, Selective tuning system; 1,195,632, W. C. White, Circuit connections of electron discharge apparatus; 1,239,852, F. K. Vreeland, Receiver of electrical impulses; 1,544,081, same, Transmitting intelligence by radiant energy; 1,251,377, A. W. Hull, Method of and means for obtaining constant direct current potentials; 1,573,374, P. A. Chamberlain, Radio condenser; 1,618,017, F. Lowenstein, Wireless telegraph apparatus; 1,728,879, Rice & Kellogg, Amplifying system, D. C., N. D. Ill., E. Div., Doc. 12,501 Radio Corp. of America et al. v. E. H. Scott Radio Laboratories, Inc. Dismissed without prejudice Dec. 29, 1932.

1,251,377, A. W. Hull, Method of and means for obtaining constant direct current potentials; 1,297,188, I. Langmuir, System for amplifying variable currents; 1,811,095, H. J. Round, Thermionic amplifier and detector; Re. 18,579, Ballantine & Hull, Demodulator and method of demodulation, D. C., S. D. N. Y., Doc. E 74/457, Radio Corp. of America et al. v. H. F. Lyman (Lyman Mfg. Co.) et al. Consent decree for plaintiff (notice Apr. 27, 1933.)

1,231,764, F. Lowenstein, Telephone relay; 1,618,017, same, Wireless telegraph apparatus; 1,403,475, H. D. Arnold, Vacuum tube circuit; 1,465,332, same, Vacuum tube amplifier; 1,573,374, P. A. Chamberlain, Radio condenser, filed May 19, 1933, D. C., S. D. N. Y., Doc. E 76/56, Radio Corp. of America et al. v. Insuline Corp. of America.

1,251,377, A. W. Hull, Method of and means for obtaining constant direct current potentials; 1,297,188, I. Langmuir, System for amplifying variable currents; 1,702,833, W. S. Lemmon, Electrical condenser; 1,811,095, H. J. Round, Thermionic amplifier and detector; Re. 18,579, Ballantine & Hull, Demodulator and method of demodulation, filed May 19, 1933, D. C., S. D. N. Y., Doc. E 76/57, Radio Corp. of America et al. v. Insuline Corp. of America.

1,710,073, 1,714,191, S. Ruben, Electrical condenser; 1,891,207, same, Electrolytic condenser, filed May 17, 1933, D. C., S. D. N. Y., Doc. E 76/50, Ruben Condenser Co. et al. v. The Rudolph Wurlitzer Co., Doc. E 76/51, Ruben Condenser Co. et al. v. Alan Radio Corp. Doc. E 76/52, Ruben Condenser Co. et. al. v. Howell Electric Motors Co.

1,755,114, L. A. Hazeltine, Unicontrol signaling system; 1,755,115, same, Variable condenser, D. C., E. D. N. Y., Doc. E 6723, Hazeltine Corp. v. Abraham & Straus, Inc. Consent decree for plaintiff May 16, 1933.

1,815,768, A Georgiev, Electrolyte, C. C. A., 2d Cir., Doc. 12589, Aerovox Corp. v. Concourse Electric Co., Inc. Decree reversed (notice May 15, 1933).

1,845,306, 1,857,055, W. A. McDonald, Coupling system, D. C., E. D. N. Y., Doc. E. 6724, Hazeltine Corp. v. Abraham & Straus, Inc. Consent decree for plaintiff May 16, 1933.

1,852,710, L. A. Hazeltine, Antenna coupling system, D. C., E. D. N. Y., Doc. E 6725, Hazeltine Corp. v. Abraham & Straus, Inc. Consent decree for plaintiff May 16, 1933.

1,231,764, F. Lowenstein, Telephone relay; 1,403,475, H. D. Arnold, Vacuum tube circuit; 1,465,332, same, Vacuum tube amplifier; 1,507,016, L. de Forest, Radio-signaling system; 1,507,017, same, Improvement in wireless telegraph and telephone system; 1,618,017, same, Wireless telegraph apparatus, D. C., S. D. N. Y., Doc. E 73/253, Radio Corp. of America et al. v. John Wanamaker of N. Y. Consent decree for plaintiff (notice May 13, 1933).

1,173,079, E. F. Alexanderson, Selective-tuning system; 1,195,632, W. C. White, Circuit connections of electron discharge apparatus; 1,239,852, F. K. Vreeland, Receiver of electrical impulses; 1,544,081, same, Transmitting intelligence by radiant energy; 1,573,374, P. A. Chamberlain, Radio condenser; 1,728,879, Rice & Kellogg, Amplifying system; Re. 18,579, Ballantine & Hull, Demodulator and method of demodulation, D. C., S. D. N. Y., Doc. E 73/254, Radio Corp. of America et al. v. John Wanamaker of N. Y. Consent decree for plaintiff (notice May 13, 1933).

1,648,808, L. A. Hazeltine, Wave signaling system, D. C., E. D. N. Y., Doc. E 6722, Hazeltine Corp. v. Abraham & Straus, Inc. Consent decree for plaintiff May 16, 1933.

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....A Bakelite Molded case "retains its good looks through all kinds of service"

"IN THE HANDS of thousands of owners the original Kadette has proven the complete desirability of Bakelite Molded where continuous portability is essential. Bakelite Molded will not dent nor is it easily marred. It retains its good looks through all sorts of service." This is the endorsement of the manufacturer of Kadettes, who is again using Bakelite Molded for the case of his new portable model.

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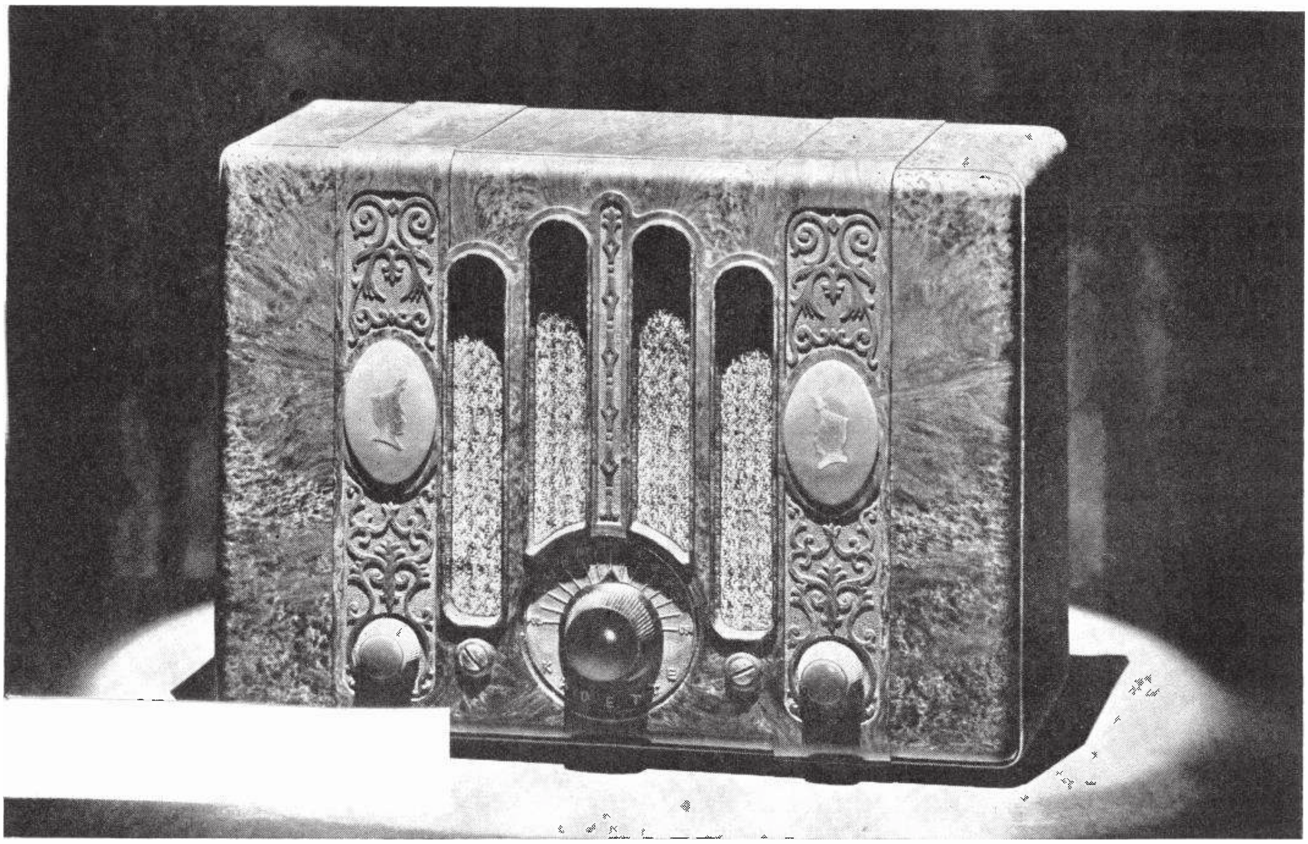

New model Kadette with Bakelite Molded case and knobs. Product of International Radio Corp., Ann Arbor, Mich.

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BRITISH PATENTS

IN THE FIELD OF ELECTRONICS

Amplification, Detection, Etc.

Gas-tube amplifier. A pair of vapor electric tubes connected in push-pull and across a d-c supply. The grids are supplied with a 60-cycle input together with a 1,000-cycle frequency from a tube arranged to provide oscillations of triangular wave form. The high frequency stimulates the tube in alternate half cycles, while the induced voltage across a reactance in the high voltage supply cooperates with a condenser to reduce the plate potential of each tube in succession below the critical threshold value. The combined voltage applied to each grid is shown in curve 1; curve 2 is an oscillogram of the output from one of the tubes, the effect of the applied signal being to increase the time period during which each tube is conductive from a minimum to a maximum in rhythm with the signal voltage, and curve 3 represents the amplified signal output after the high-frequency component has been removed. B. D. Bedford, assigned to British Thomson-Houston Co. No. 389,855.

FIG.1

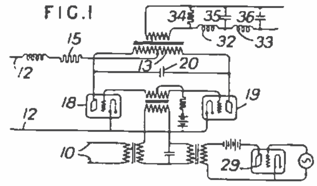
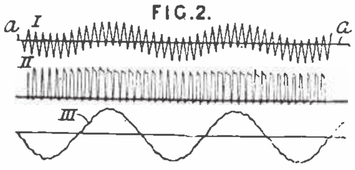


FIG.2.



Impedance network. Tuned circuit coupled to an a-c source usually with another tuned circuit to form a bandpass filter by means of a resistance of approximately the same value as the impedance of the tuned circuit at resonance. R. E. H. Carpenter and P. P. Eckersley, Chelsea, London. No. 389,896.

Harmonic producer. For use in tone frequency multiplex telegraphy harmonics are extracted from a square, triangular or other wave form comprising odd harmonics only and their amplitudes are equalized by means of condensers or inductances. Thus from a fundamental of 60 cycles, signaling frequencies of 420, 540, 660, etc., may be obtained. D.C. Espley, G. E. Co., Ltd. No. 389,917.

High-frequency generator. A low-frequency arc in a medium of high dielectric strength, such as liquid hydrogen, is ignited and maintained by an auxiliary circuit having a condenser and a spark gap fed by an alternator with a frequency exceeding 200 cycles and preferably between 500 and 1,000 cycles. Societe l-Air Liquide, Paris. No. 389,946.

Trigger circuit. A trigger relay in which the output is independent of the input so long as it is above a critical value. G. E. Co., Ltd. No. 389,970.

Uniform amplifier. Method of giving uniform amplification over a band of frequencies by giving the input circuit of a receiver a higher amplification at low frequency than at high frequency. This is achieved by connecting an inductance in series with the aerial system which is resonant at a frequency higher than the highest frequency in the received band. Marconi Co. No. 391,021.

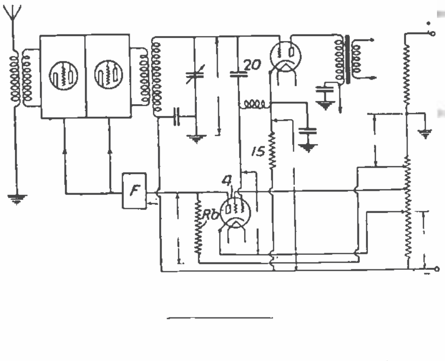
Television system. A color television system, a transmitter utilizing a non-color record or film. H. E. Ives, assigned to E. R. P. I. No. 390,158.

Television system. Picture currents of constant frequency and varying amplitude are rectified and combined with a screen frequency to produce signals of constant amplitude and frequency but varying duration which are shaped so as to be of square wave form and used to key a carrier frequency. The screen frequency governs the frequency at which the signals of constant amplitude occur and therefore the detail of the reproduced picture. H. Shore and J. N. Whittaker, Marconi Co., 390,400.

Variable mu tube. Various methods for obtaining variable mu effect, for example, a cathode of different emissivity at different parts, an anode with non-uniform openings, and a control or screen grid non-uniform as regards mesh or distance from the cathode. Telefunken. No. 390,998.

Screen grid amplifier. To increase the energy amplification of the screen grid stage of a radio transmitter the screen voltage is raised so that the plate current reaches a saturation value with a control grid voltage that does not produce grid current. Phillips. No. 391,392.

Automatic volume control. Means which serve both as a d-c amplifier for the d-c component of the normal detector and also as a rectifier for producing d-c component for gain control. P. O. Farnham, Marconi Co. No. 391,373.



Push-pull. A series-connected diode detector coupled to a push-pull low-frequency amplifier by means of a pair of resistances or impedances between ground and the tube cathode and the low potential end of the tuned input circuit. H. Jackson, Lancashire. No. 390,669.

Protective system. To prevent dangerous rises in voltage in a thermionic amplifier a neon tube is connected across the input circuit the breakdown voltage being such that voltages exceeding a certain value are suppressed. J. F. Cook, Marconi Co., No. 390,688.

Television. The received picture signals are combined with impulses generated at the receiver to form square-front waves to compensate for the absence of high frequency components in the received signals. Television Laboratories, San Francisco. No. 390,565.

Removal of gas. Occluded gas is removed from a cathode by bombardment by electrons emitted from a substance applied to another electrode, such as the anode or grid. Barium azide may be attached to the inside of the anode which is heated by a high frequency field during evacuation so as to evolve nitrogen and leave barium. A positive potential is applied to the cathode and the anode is heated so that electrons are emitted from the barium. After the cathode has been freed from gas the anode may be raised to a higher temperature so that barium is deposited on the cathode to form an electron emitting coating. Philips, No. 382,520.

Control circuits. A relay for tripping a circuit breaker is energized with a time delay varying inversely with a potential drop across a resistance. This delay is provided by a tube, the grid of which is biased by the potential of a condenser slowly charged through a resistance. O. C. Traver, British Thomson Houston Co. No. 386,370.

Distortion compensation. In an amplifier having a drooping characteristic, an auxiliary tube is arranged to supply additional energy to the amplifier so as to strengthen the characteristics. C. W. Hansell, Marconi Co. No. 386,540 and No. 386,501.

Electron Tube Application

Control device. The temperature of a heated object is controlled by directing the light alternately with the standard light to the light sensitive cell. D. C. Prince, British Thomson-Houston Co. No. 390,776.

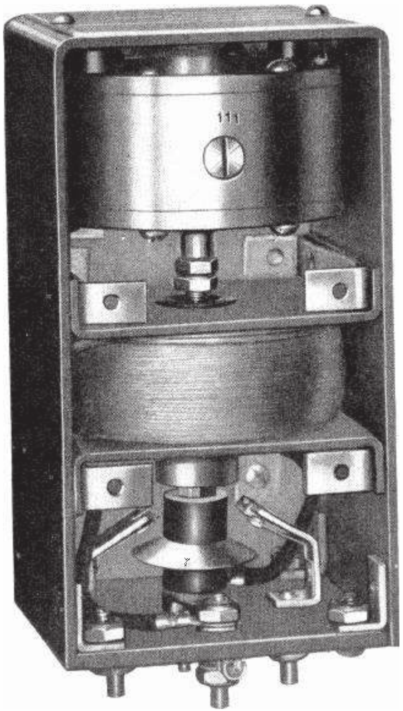
Medical apparatus. High-frequency (over $3x10^{7}$) generator connected with the actual treatment apparatus by means of a transmission system of the Lecher wire type. Siemens & Halske, Berlin. No. 390,247.

Burglar alarm system. Method of detecting the presence of an approaching person or body by means of a gas-filled rectifier whose discharge is initiated by a capacity effect. F. Dobosz, Vienna. No. 390,307.

Sodium vapor lamp. Control circuits. Philips, No. 390,729.

AGASTAT.. A NEW TIME DELAY RELAY

Wide Range—Adjustable—Compact—Immediate Recycling



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Principle—The timing unit, being hermetically sealed and compensated, is unaffected by dust, temperature or humidity changes. The timing period is not affected by fluctuations of voltage. The design of the timing head is based on twenty-five years of experience in the manufacture of diaphragm type timing devices for marine lighthouses. A volume of inert gas is confined in the timing head by two special diaphragms. These diaphragms are made from the same type of special leather that has been used so successfully in AGA flashing marine lighthouses. These marine lighthouses, flashing more than ten million times per year for many years, accurately maintain the period of light and dark in accordance with a predetermined setting. The conditions under which these unattended lighthouses operate are very severe and range from the humid heat of the Tropics to the intense cold of the Arctic. The reliability of AGA diaphragm operated devices is known all over the world.

Application—For all types of plate voltage switching; voltage limitators; general automatic timing of electrical and mechanical processes; photo-switch time delay for temporary darkness; delaying and sustaining of photo-electric and thyratron controls; alarm systems; for cathode ray and special tube supply voltage switching; telephone and telegraph central office time delay; remote control and switching of power line equipment; elevator control.

Available in a wide range of types of operation, voltages, frequencies, time limits and initial settings.

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Technical Details
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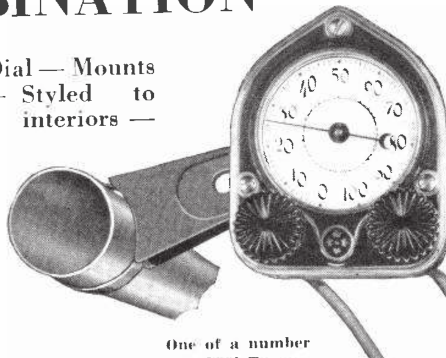
Airplane Dial — Mounts Anywhere — Styled to match car interiors — Standard Finishes Include Black & Chromium. Special Finishes to order.



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Here is why—

1. Styled eye value adds sales appeal
2. Renders the set adaptable to any car
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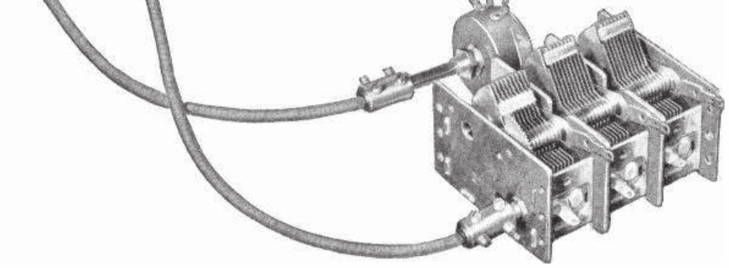
4. Service free operation results in user's satisfaction
5. Permits volume control to be mounted on chassis
6. Condenser geared especially for auto radio tuning
7. Both units have high safety margin required in auto radio usage



The new matched DeJur Control and Geared Condenser are made available in the spirit that permanent sales success of auto radios dependent on trouble free installation and use. The DeJur Control uses the highest quality shaft, Genuine Bakelite Knobs, Key Lock Control, Waterproof Die Cast Case and a specially designed mounting bracket that fastens with but one screw yet permits universal mounting. Our engineers will be glad to work with recognized manufacturers. Set design data upon request.

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New Lower Prices Improved Designs

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New AmerTran SilCor Audio Transformers

of modern design at popular prices

AmerTran SilCor Transformers have been developed to satisfy the demand for quality audio transformers at popular prices. They are similar in design and construction to "De Luxe" transformers but have core laminations of silicon steel instead of high permeability alloy. They are highly satisfactory for all usual requirements in public-address equipment and other commercial requirements.

	DE LUXE LINE		SILCOR LINE	
	Type No.	List Price	Type No.	List Price
Interstage: 1 pl. to 1 gr., 0 dB	D-12	$7.00	J-711	$4.50
Interstage: 1 pl. to p/p gr., 10 dB	D-21	8.50	J-721	5.00
Interstage: p/p pl. to p/p gr., 18 dB	D-51	10.00	J-751	6.00
Input: 200 or 500 w. to 1 gr., 0 dB	D-81	10.00	J-771	5.50
Output: 1-227 pl. to 200 or 500 w., 10 dB	D-31	8.50	J-731	5.50
Mixer: 200 or 500 w. to 200 or 500 w., 0 dB	D-91	8.50	J-791	5.50
Output: p/p 2A3 pl. to 15/7½/5/3¾ w., 34 dB	D-64	18.00	J-822	5.50
Output: p/p 2A3 pl. to 500 and 15 w., 34 dB	D-103	18.00	J-752	5.50
Output: 500 w. to 15/7½/5/3¾ w., 34 dB	D-132	12.00	J-831	8.00

NOTE: Above tabulation lists only nine popular types—complete catalog on request. List Prices effective August 1, 1933.

American Transformer Company
Transformer builders for over 31 years
178 Emmet St., Newark, N. J.

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KEEP IN TOUCH WITH RESINOX DEVELOPMENTS

4TH QUARTER

Radio manufacturers are girding for the best selling season of their year—the fourth quarter of 1933. Recent sixty and ninety day developments have encouraged all of them to an expectation that sales in the fourth quarter of the year may exceed the most optimistic quotas.

This will probably mean considerable last-minute purchasing of the things that go to make up radio sets. Such a condition points to a favorable prospect for the manufacturers who sell to radio factories. It means that an advertisement in *Electronics'* September and October issues and even in its November and December issues may be able to pick up those extra, last minute orders that radio and allied manufacturers may have to place before the year closes.

Naturally, an advertisement in the next four issues of *Electronics* serves notice to over 7,000 executives and engineers that your product is available to help them in their manufacturing work.

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BRIDGES WIRE NETWORKS
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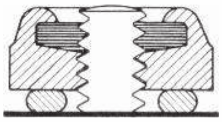
USE

Elastic Stop NUTS

Reliability and permanency of electrical contracts is assured through the use of Elastic Stop Nuts. Their use assures terminal connections of low contact resistance. They make simple, permanent and dependable terminal fastenings. They can be tightened and loosened, used indefinitely with no impairment in locking effectiveness.



Users of Elastic Stop Nuts for regular production include manufacturers of quality radio receivers, government aircraft equipment and ship communications apparatus, instruments, etc.

Technical data on terminal lock nuts and their application is available.

A. G. A. COMPANY
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ELIZABETH, N. J.

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Coils, Magnet Wire Wound

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For over 25 Years, suppliers to the largest radio and electrical manufacturers.

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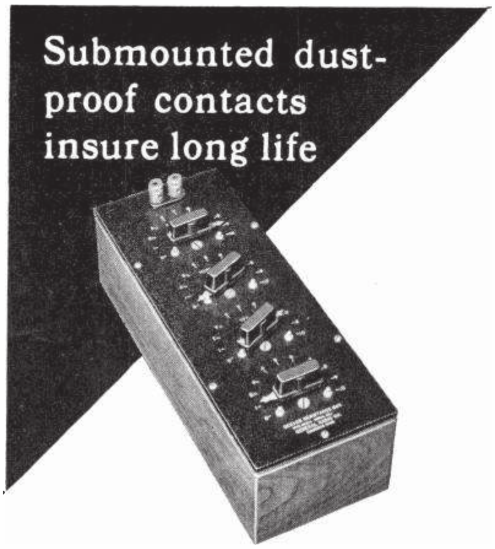

DECADE-RESISTANCE BOXES . . . *Improved design means improved performance*

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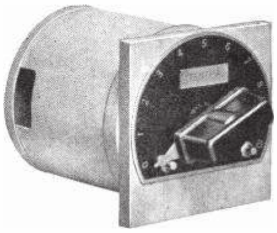

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Individual decades of resistors as used in the decade-resistance boxes are available for use in your own laboratory-built instruments. Prices range from $8.50 to $16.00. Consult Catalog G-F.

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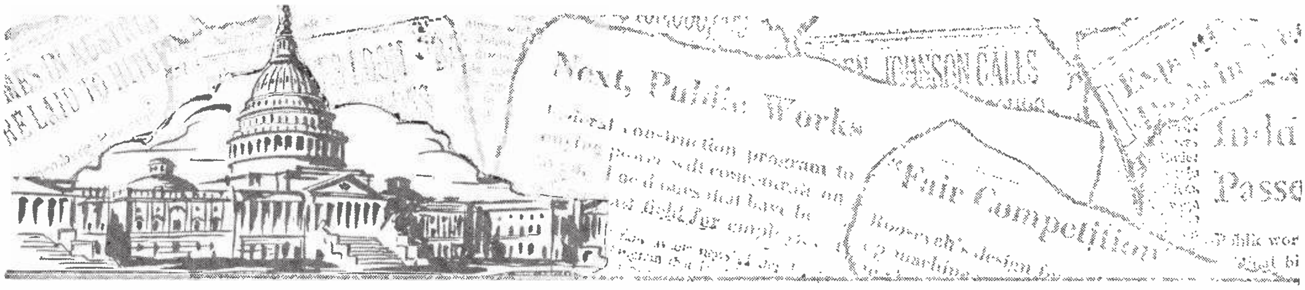
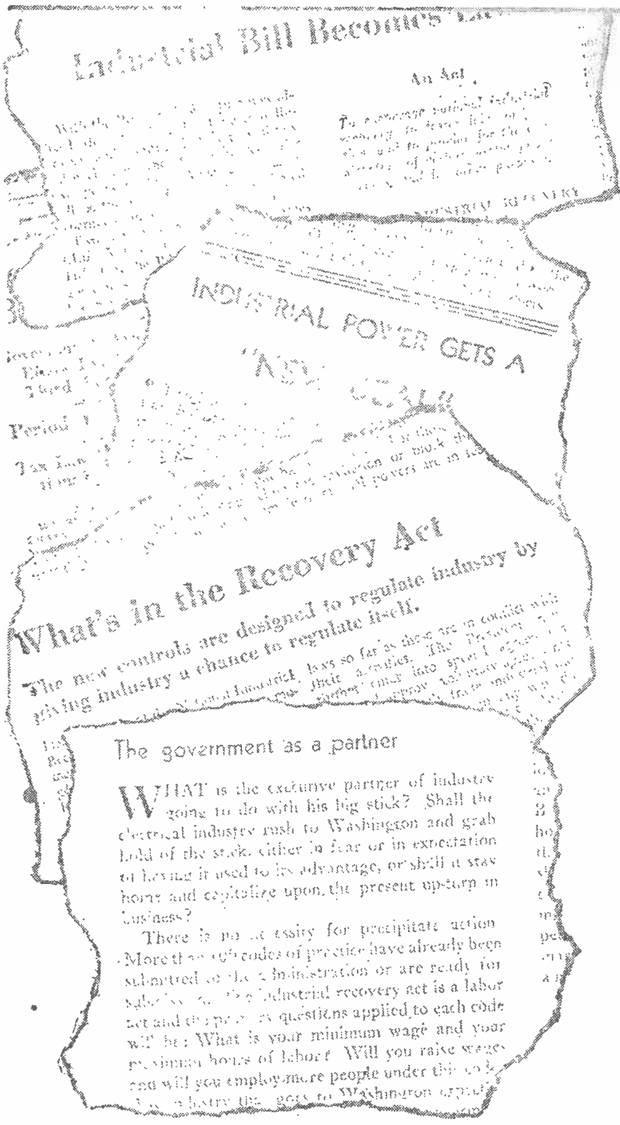
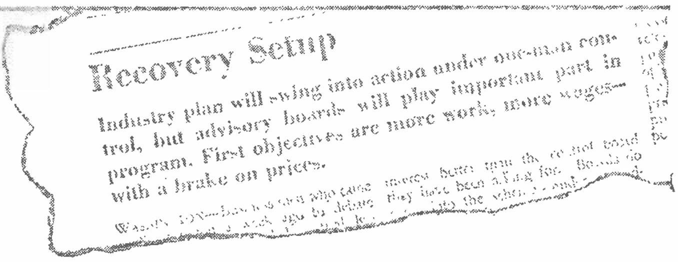


"But". . . . *asks Business,* "what


Industrial Bill Becomes
An Act
INDUSTRIAL POWER GETS A
What's in the Recovery Act
The new controls are designed to regulate industry by giving industry a chance to regulate itself.
The government as a partner


Recovery Setup
Industry plan will swing into action under one-man control, but advisory boards will play important part in program. First objectives are more work, more wages—with a brake on prices.

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Epoch-making news is coming out of Washington. The newspapers are full of it. Headline-writers dramatize it. Editors comment on it. Cartoonists play with it.

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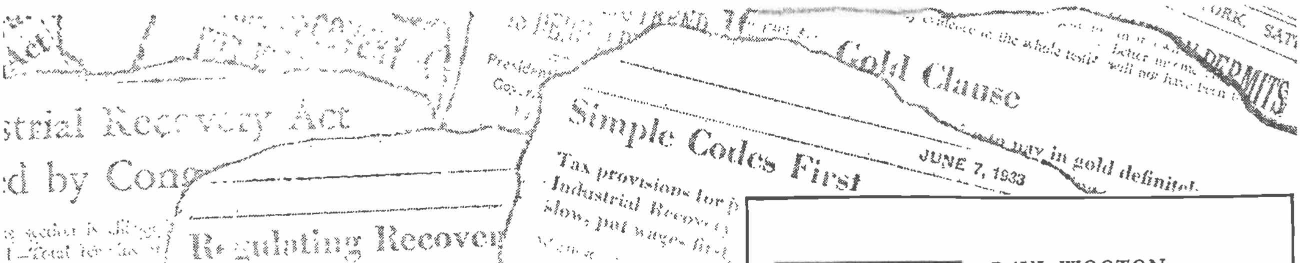
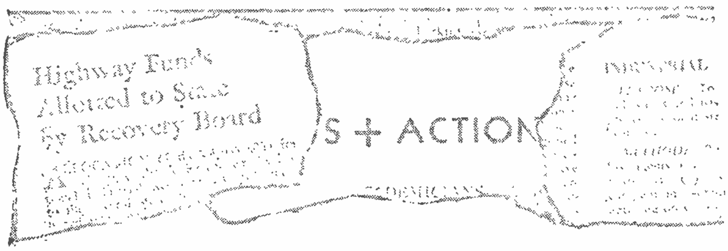


does it all mean?”



its Washington service . . .

dents assigned to the seat of national recovery activities. McGraw-Hill has maintained a Washington Bureau for many years to keep its readers apprised of National developments. Paul Wooton, veteran Washington correspondent, has reported the National news for McGraw-Hill papers since 1917. With him in recent years have been associated Carter Field and Irvin D. Foos. To this eminent Washington staff have now been added the full time services of Wallace Thompson, editor of Ingeniería Internacional. In New York, Edward P. Warner, editor of Aviation and former Assistant Secretary of the Navy, has been assigned the task of editorial direction and coordination of effort in matters relating to the National Recovery Act. Another McGraw-Hill representative, O. Fred Rost, has been assigned to devote his entire time to the various trade associations which have suddenly been lifted to a position of heretofore undreamed-of responsibility.

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Taught school and did newspaper work in Mexico. With New Orleans Times-Picayune since 1911, Washington correspondent in 1914. McGraw-Hill Washington correspondent since 1917. Associated with many activities of the corps of correspondents in Washington. President of Overseas Writers and two terms chairman Board of Governors of National Press Club. Has covered various assignments for McGraw-Hill Publications in Europe.

CARTER FIELD

McGraw-Hill correspondent and feature writer for Bell Syndicate since 1929. Former Washington correspondent of the New York Herald-Tribune and its predecessor the New York Tribune from 1915-1929. Former President National Press Club. Member of the National Press, Gridiron and Metropolitan Clubs.

WALLACE THOMPSON

Chief editor of Ingeniería Internacional and author of books on industrial relations with Latin America. A member of the original staff of the United States Daily as expert on foreign affairs, later of trade and industry. Newspaper experience in Paris and Mexico City. Member Century, Explorers, National Arts, Cosmos and National Press Clubs. Fellow of the Royal Geographical Society.

IRVIN D. FOOS

Business paper correspondent in Washington since 1920. A member of the Washington staff of McGraw-Hill since 1929 and also Transportation Editor of BUSINESS WEEK. Active in organization of Business Paper Correspondents Committee in Washington. Member National Press Club.

O. FRED ROST

Marketing Editor of BUSINESS WEEK. Since 1928 director surveys of distribution, McGraw-Hill Publishing Co. For 19 years active in national trade associations of important industries as member or observer. Author of books and articles on the practical mechanics of business and cooperative effort in business. Received McGraw Award, electrical industry, 1927.

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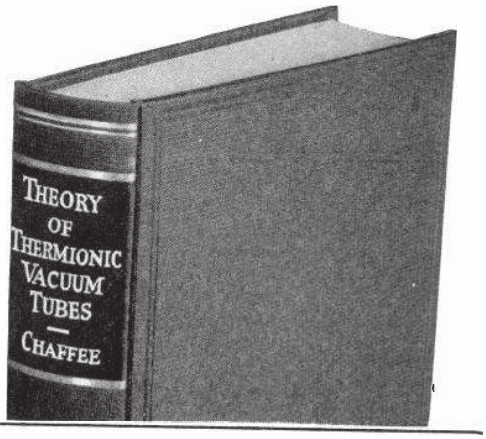

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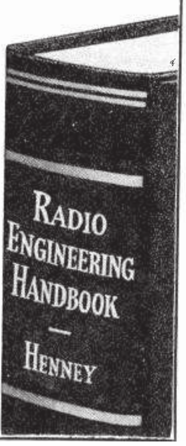

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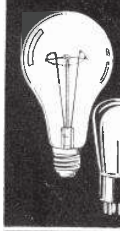

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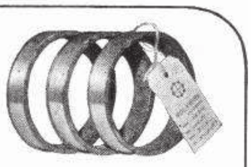

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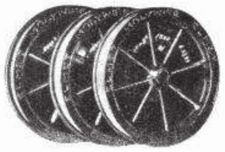

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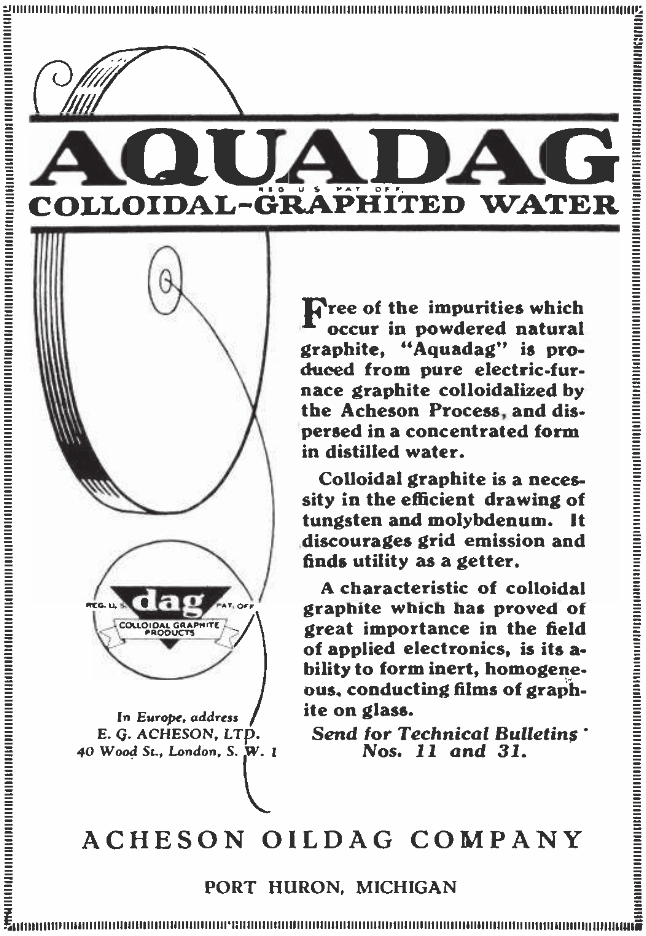

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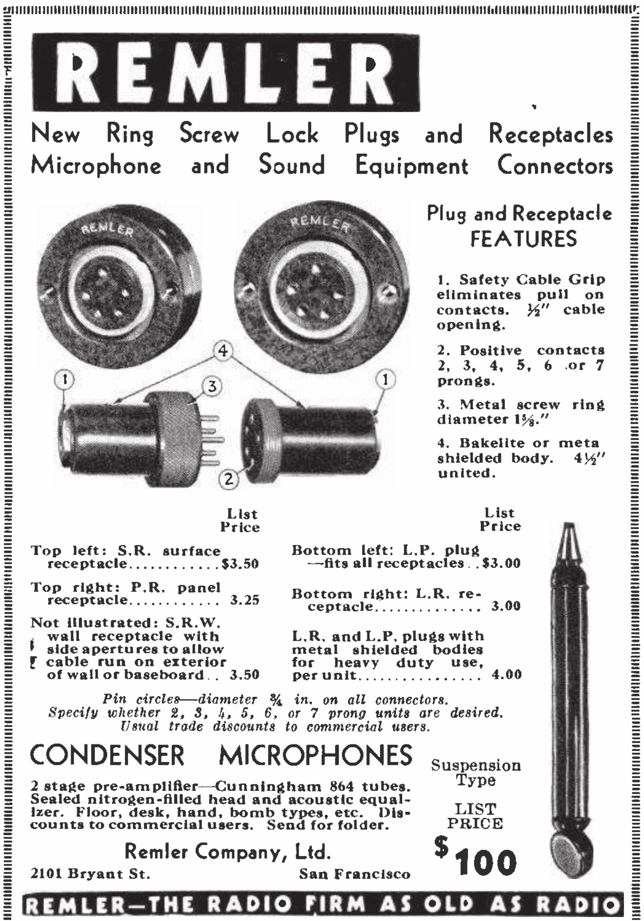

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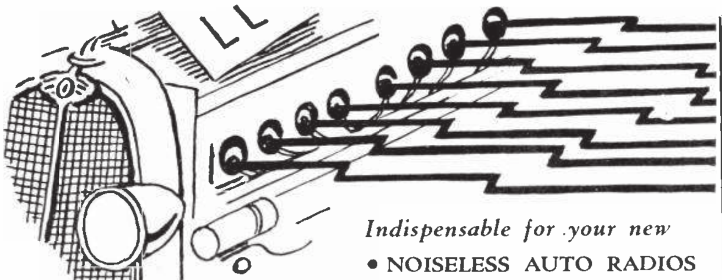

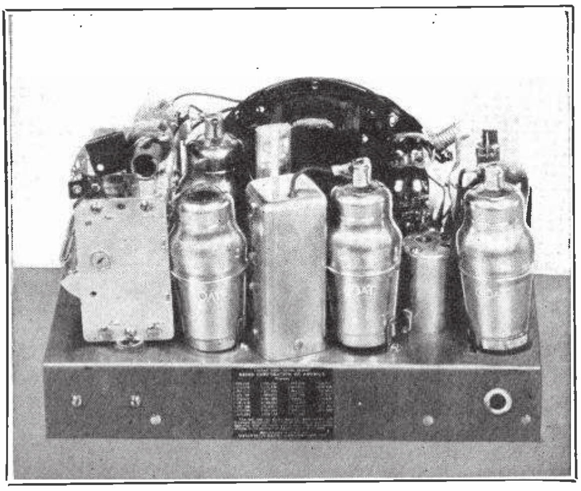

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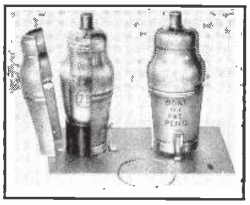

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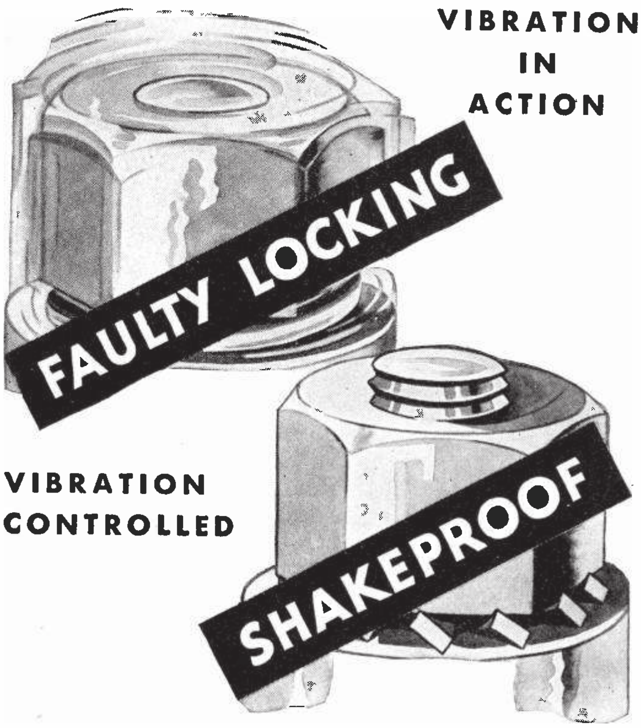

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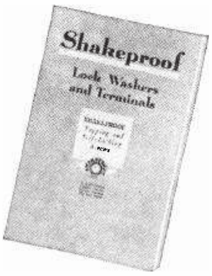

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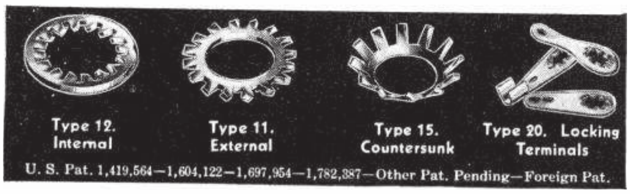

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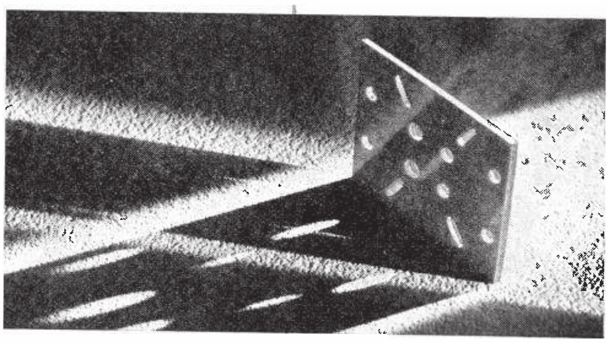

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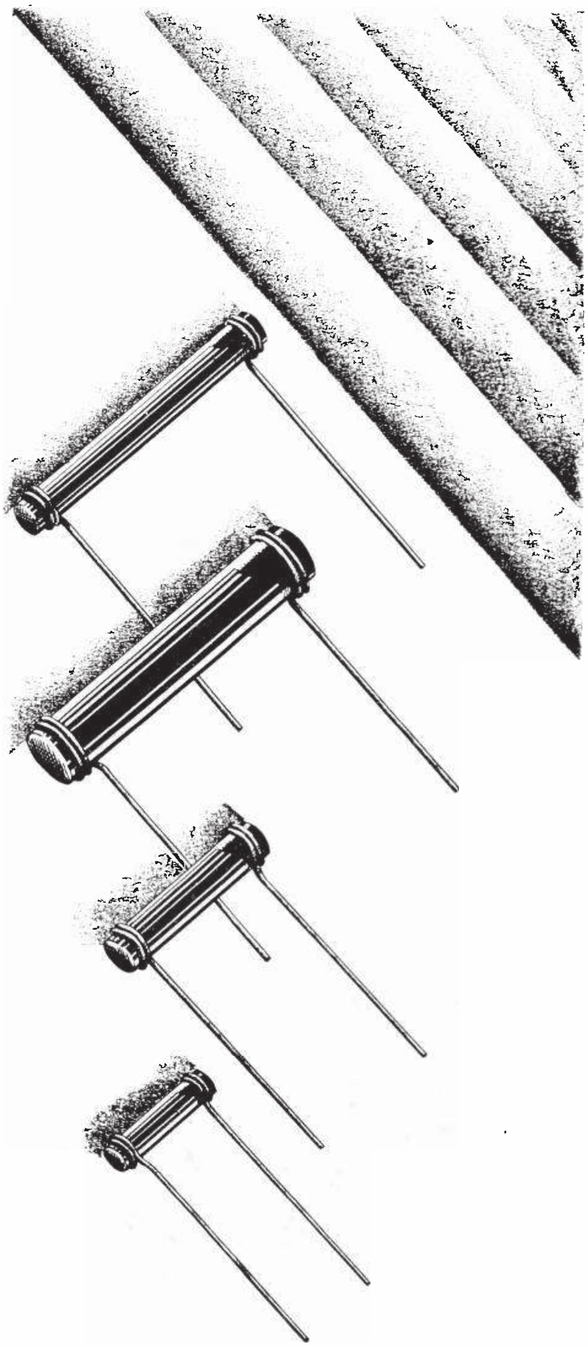

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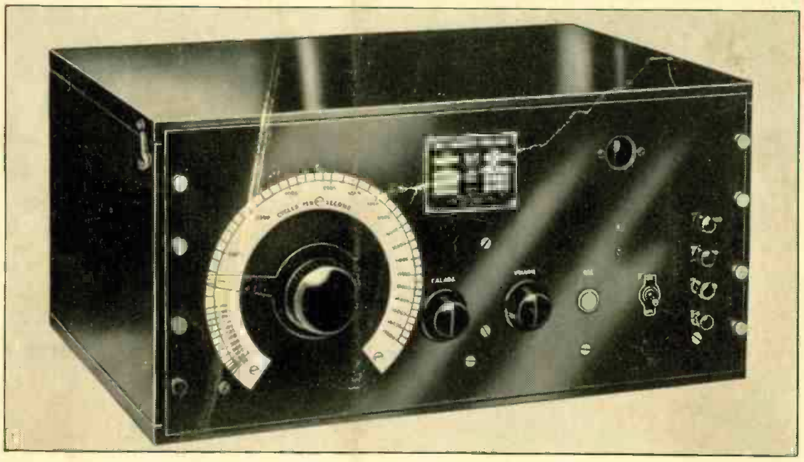

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Beat Frequency Oscillator

RCA Victor has recently produced another new and interesting precision instrument for the laboratory.

It is the Type TMV-52-A Beat Frequency Oscillator. This instrument is also valuable for improving the overall fidelity of audio frequency networks in broadcasting equipment, sound motion picture equipment and in the many other subdivisions of radio and electrical sound work.

A great aid for obtaining frequency characteristics is a continuously variable Audio Frequency Generator, and the many advantages found in the use of the Beat Frequency Generator principle makes this type of oscillator practically indispensable in the laboratory.

The new Beat Frequency Oscillator shown above can also be supplied for rack mounting. It is carefully engineered throughout . . . a product characteristic of "Radio Headquarters."

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electronics

radio, sound, communications and industrial applications of electron tubes • • • design, engineering, manufacture

Progress in Industry Code

•

Cost versus quality in loudspeakers

•

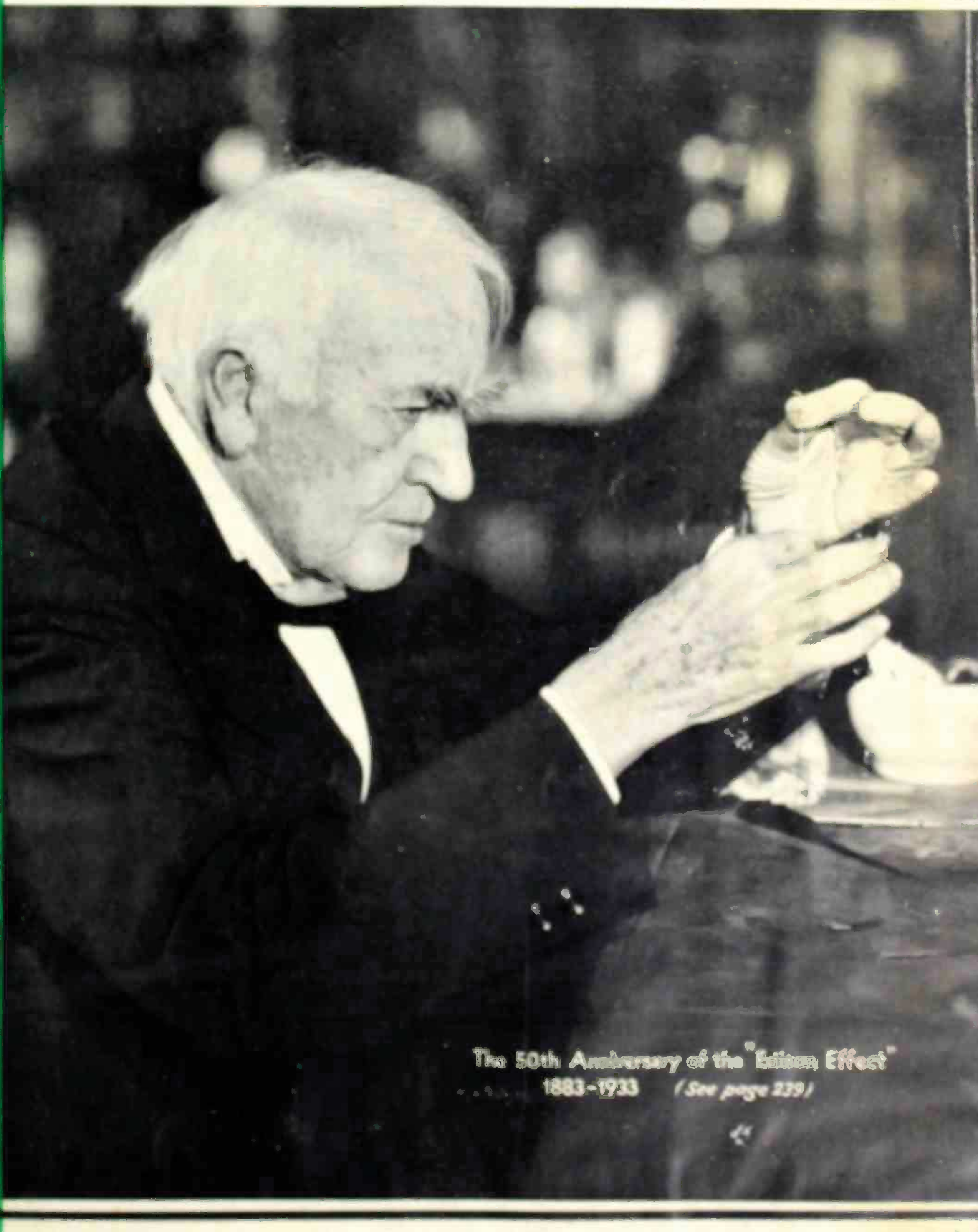
Testing mercury-vapor tubes

•

An electron microscope

•

Electron tube emitters



The 50th Anniversary of the "Edison Effect"
1883-1933 (See page 239)

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SEPTEMBER, 1933

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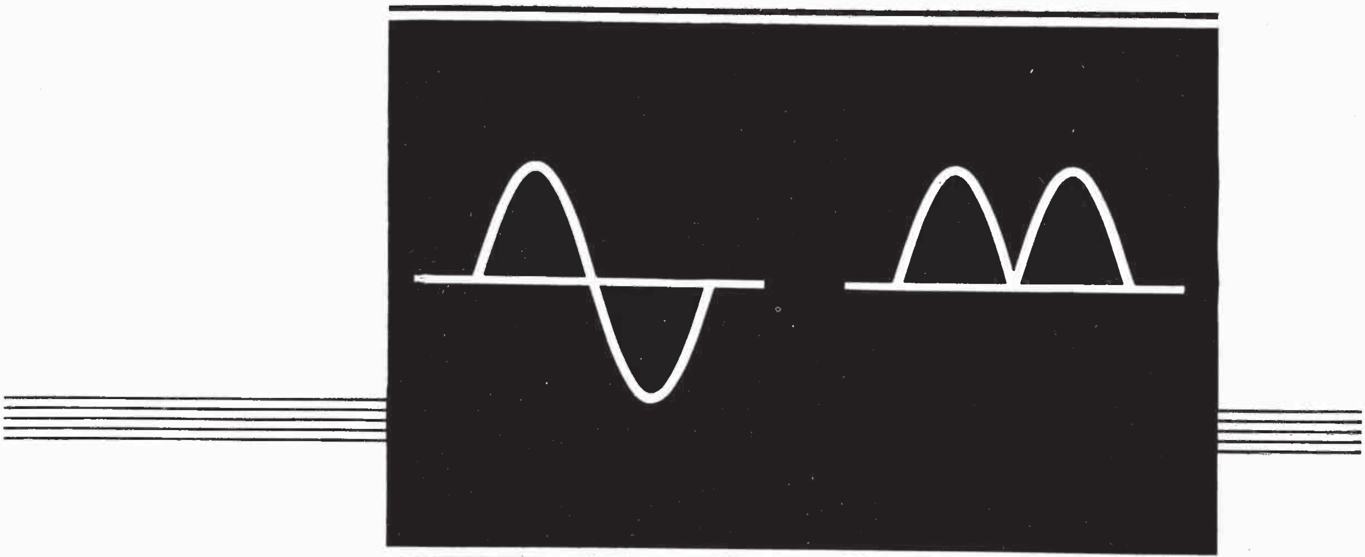

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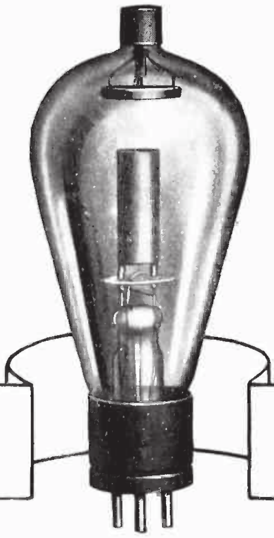
For engineers and scientists interested in the application of rectifier tubes to industrial and experimental problems, General Electric offers an extensive line of hot-cathode, mercury-vapor, and high-vacuum electron tubes.

The varied types, sizes, and characteristics available afford the user an opportunity of obtaining a "valve" best suited to his requirements. Satisfactory performance is assured by G-E tubes because of their high efficiency, good regulation, and long life.

Write for details on these G-E rectifier tubes. Also, if you desire information regarding other G-E tubes for amplification, light-sensitive response, control, measurement, etc., our specialists will gladly assist you. Address the nearest G-E office, or General Electric, Dept. 6A-201, Schenectady, N. Y.



STANDARD G-E RECTIFIER TUBES

High-voltage, high-vacuum type — KC-1, KC-3, KC-4, FP-78, FP-84, FP-92, KP-2
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Low-voltage, mercury-vapor, glass type — FG-26, FG-28, FG-32
Low-voltage, full-wave, mercury-vapor type—FG-119
Large, mercury-vapor, metal type — FG-52

301-139

GENERAL ELECTRIC

ELECTRONICS, September, 1933. Vol. 6, No. 9. Published monthly, price 35c. a copy. Subscription rates—United States, Mexico and Central and South American countries, $3.00 a year. Canada, including duty, $3.50 a year. All other countries, $4.00 a year or 20 shillings. Entered as second class matter April 4, 1930, at Post Office at New York, N. Y., under the Act of March 3rd, 1879. Printed in U. S. A. Cable address "McGrawhill, New York." Member of A.B.P. Member of A.B.C. Copyright 1933 by McGraw-Hill Publishing Co., Inc., 330 West 42d Street, New York, N. Y.

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Whatever your problem in acoustics, we can help you find the correct solution, for Magnavox has pioneered, not only in the development of speakers, but in the Electrolytic field as well. That's why Magnavox is known as . . .

SPEAKER AND CAPACITOR HEADQUARTERS

The Magnavox Company

FORT WAYNE, INDIANA

SUMMERILL ADDS MORE EMPLOYEES TO PAY ROLL

SMALL TUBE DEPARTMENT NOW RUNNING 24 HOURS

Radio Industry Takes Increased Output of Pure Nickel Tubing

INCREASING demands of the radio industry for nickel tubing have made it necessary for the Summerill Tubing Company to increase further the output of the small tube department at their Bridgeport plant.

Beginning with Monday, August 21st, this department operated 24-hours per day, with three 8-hour shifts.

This activity is due to the fact that precision tubing of pure nickel is ideally suited for use in electronic tubes and other radio purposes, and also because of the low present cost of this material.

The Summerill Company during 1930, 31 and 32, revamped and modernized its equipment and manufacturing processes so that radio tubing today is sold at one sixth the price which prevailed in 1929.

The Summerill Tubing Company located in Bridgeport 23 years ago. It was founded in Philadelphia in 1899. The first plant was a single room, 20′ x 30′, and the first product was precision steel tubing. In a short time only, however, other metals, brass, copper, aluminum, nickel silver, etc., were being manufactured.

Practically all of the materials manufactured by the company were taken by concerns that even, at that time, wanted to escape the necessity of machining the tubes which were used in their processes, and the business from the beginning was a success.

In 1910 the company moved to its present location and spread out into larger sizes and heavier wall tubing.

In 1914 the company succeeded in obtaining practically the entire hypodermic needle tubing market in this country, and ever since it has dominated that field.

Because of their experience in producing very small tubes, the radio industry turned to the company when pure nickel was found to be the most suitable metal in connection with the production of radio tubes. The company was prepared to produce large quantities, and in 1928 set about taking care of this additional demand upon its facilities. This business grew to such an extent that in 1929, even though its other lines were being produced by the company at a higher rate than ever before, the radio tube manufacturers took the largest percentage of the company's total output for that year.

Now, as in 1929, the radio industry takes a larger percentage of the company's output than any other line of business the company serves.

SUMMERILL TUBING CO.

(RADIO TUBE DIVISION)
Bridgeport (Phila. Dist.) Pa.

AGAIN OBSOLESCENCE TAKES IT ON THE CHIN!

Announcing

A *New* Weston TUBE CHECKER

NO LONGER is there any need for worrying about tube checker obsolescence. Again Weston has supplied the solution; providing a design with 18 sockets, 11 of which are wired to test all of the present tubes, some 90 in number. The remaining 7 sockets are spares, and can be quickly wired in to test some fifty-odd additional tubes, when and if these tubes appear on the market.

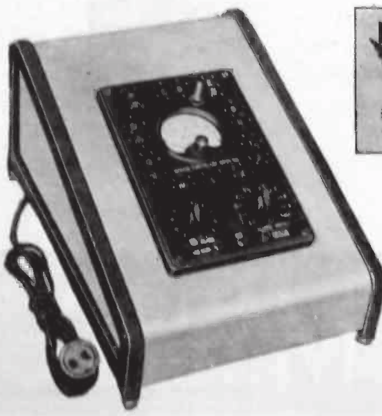
Weston Model 674 Tube Checker is an "English Reading" tester—and is outstanding in its simplicity of operation. All reference to or knowledge of tube characteristics is avoided. The operator simply follows the few concise steps indicated on the tube limit chart and correct indication is obtained in minimum time.

Moreover, by means of the cathode leakage button the testing of all cathode type tubes for leakage between cathode and heater is readily accomplished—and in the same socket used for regular tests on the tube. Independent checking of the second plate in all double plate tubes also is accomplished simply by throwing a toggle switch.

And there are many more outstanding features—a few of them listed on the right. They will explain why Weston Model 674 is the outstanding value in tube checkers today. The coupon will bring descriptive circular RA. Weston Electrical Instrument Corporation, 618 Frelinghuysen Avenue, Newark, New Jersey.

OUTSTANDING FEATURES:

1. *Attractive appearance—harmoniously finished in three tones of brown.*
2. *"English Reading". Excellent readability.*
3. *Simplicity of operation—no calculations necessary.*
4. *Lowest obsolescence factor.*
5. *Tests second plates, all tubes—diodes, duplex and rectifier.*
6. *Tests cathode leakage by simply pushing a button.*
7. *Individual standard replaceable sockets.*
8. *Line voltage adjustment.*
9. *No adapters required.*



Also, the new Weston Model 673 Tube Checker. Combines attractive appearance, good testing ability, and low price. . . . Send coupon for descriptive bulletin.

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Please send circular RA containing full information on Model 674 Tube Checker and other radio instruments.

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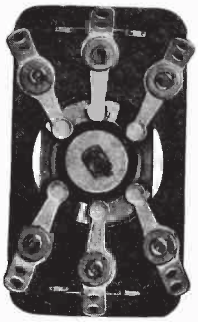

No. 2322—*Wave Switch, two pole double throw.*

The YAXLEY Line of Circuit Selector Switches Represents an Outstanding

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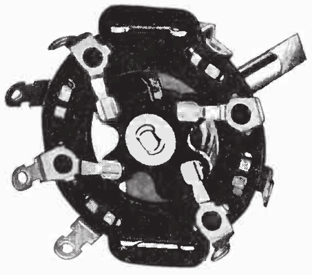
—an achievement in quality, flexibility, adaptability, and completeness.

Yaxley offers switches that meet the most rigid requirements of extensive life tests, low capacity, and low contact resistance, with a substantial factor of safety.

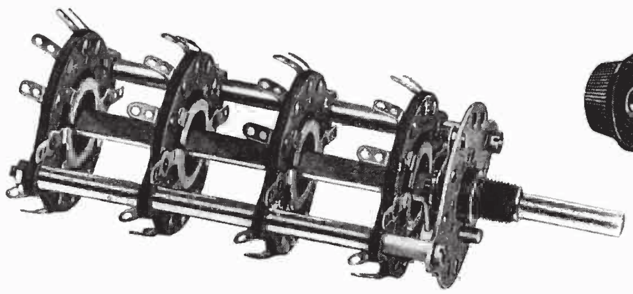
Yaxley switches simplify complex switching problems in radio receivers, instruments, meter circuits, testing devices and other radio and electrical applications.

Many types of switches are included in the complete Yaxley line. Switches in the single section types are provided with as many as six pole single throw operations. Combinations, incorporating groups of sections (each section providing several circuits assembled in a minimum space) are also available.

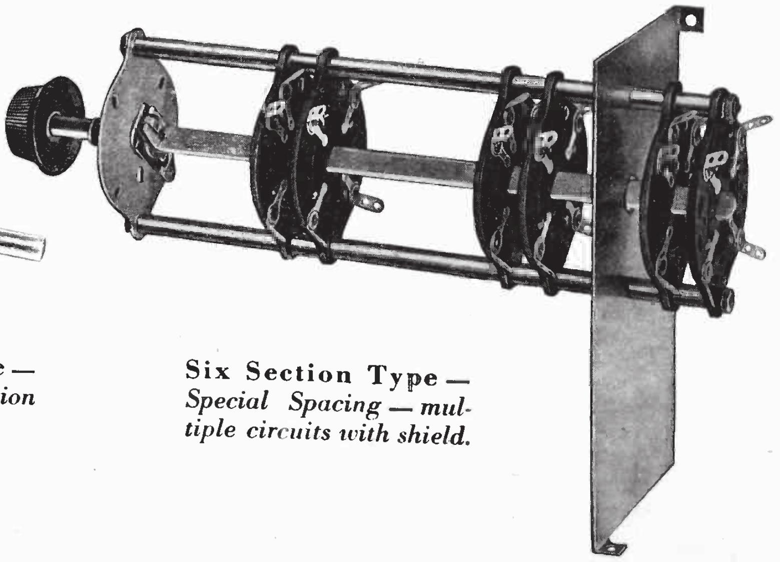
Send us your circuits—or a sketch of your switch showing circuits, contact points and spacing between sections—and we'll gladly mail a sample of the Yaxley switch that will best meet your requirements.



No. 2141—*Range Switch, four circuit, single throw.*



Four Section Type—*Two circuits, each section Standard Spacing.*



Six Section Type—*Special Spacing—multiple circuits with shield.*

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electronics

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Editor
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Associate Editor

McGRAW-HILL PUBLISHING COMPANY, INC.

New York, September, 1933

NRA
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radio
sound pictures
telephony
broadcasting
telegraphy
counting
grading
carrier systems
beam transmission
photo cells
facsimile
electric recording
amplifiers
phonographs
measurements
receivers
therapeutics
traffic control
musical instruments
machine control
television
metering
analysis
aviation
metallurgy
beacons
compasses
automatic processing
crime detection
geophysics

The New Leisure—

and the electronic arts

THE New Deal has restricted the hours of labor and thereby has introduced a tremendous amount of New Leisure. A current estimate places this sudden new recreation time at *thirteen million hours per week.*

Sooner or later this "Niagara of leisure" will have to be absorbed in part by amusements, sports and other recreations. A large part will be devoted to such electronic entertainment as radio, sound-pictures, home talkies, phonograph reproduction, synthetic musical instruments, and eventually, television.

Thus, suddenly our products are called upon to help shoulder the burden of the New Leisure. New markets are opened up for our entertainment carriers, multiplying their importance far beyond their former relationship in a world that worked long hours with little time for recreation. Now all forms of electrical entertainment find themselves in a new and rising market.

WHATEVER the restrictions placed on production and expansion in other industrial fields, under the new order of things, it is clear that a new boon and a new boom have been handed to the electronic industries of radio, sound pictures, and associated fields. The far-reaching influences of these will be more apparent as the months of NRA roll on.

Make no mistake about it. The New Leisure is a new deal for the electrical entertainment industries—an *expanding* opportunity for the electronic arts.

RADIO CAMPAIGN ON—

September sales drive to culminate in Radio Progress Week, Oct. 2 to 7

JUST fifty years ago, in 1883, Thomas A. Edison discovered the flow of electrons across the vacuum of his early incandescent lamp, laying the foundation for the whole electronic industry, radio, and other applications of thermionic amplification.

And this month, appropriately enough, the radio industry starts its sales campaign, leading to Radio Progress Week, which will be celebrated Oct. 2 to 7. Radio Progress Week thus marks fifty years of the electronic arts, beginning with the first faint phenomena detected by Edison, which thereafter lay unused for almost a generation, but now expanded into services that span the earth and entertain its peoples of every land.

Radio Prosperity Campaign

The Radio Prosperity Campaign is being conducted under the auspices of the Radio Manufacturers Association which has organized a special staff to issue campaign posters, placards, booklets and circulars to promote radio receiving set sales during September. Campaign headquarters are at 330 W. 42nd St., New York City.

Local committees have been set up in the retail and wholesale radio trade in a hundred or more cities, and the development of local radio campaigns is being pushed by these local groups. A number of radio shows are being held during the month, and newspapers are giving the subject of radio special attention, some papers even issuing radio supplements in connection with local shows and local observations. Service men's organizations are also making special drives to put all listeners' sets into best operating condition.

The September Campaign is designed to get the homes of the United States equipped with improved radio reception in order to hear the special features which will be on the air during Radio Progress Week, October 2 to 7. For this week, both the great national chains and the independent broadcasting stations are co-operating with special programs, designed to attract the attention of listeners, and to demonstrate the great advances that have been made in radio transmission and reception as a means of delivering improved realism, tone quality and musical values.

Thus during September and October a well-planned drive is underway to create more radio sales and more radio volume, which should be felt throughout the whole industry, all the way back to the set and parts manufacturers and engineers.

NRA puts radio under NEMA code

Meanwhile the radio industry has been having its code worries under the National Recovery Administration. At the time the last issue of *Electronics* appeared, it was the plan of the Radio Manufacturers Association to draft and operate under its own special Radio Code, and a committee headed by W. Roy McCanne of the Stromberg-Carlson company, worked long hours and many days in New York and Washington to shape up a code that would meet the agreement of the many interests in radio, as well as have the approval of the NRA administrator at Washington. This special radio code, as submitted, was outlined in the last issue of *Electronics*.

On August 24, however, Deputy Administrator Allen informed the RMA committee that the special Radio Code would be unacceptable to the NRA, pointing out that he considered especially objectionable (1) the provisions for setting up "average costs" of manufacture as the cost figure to be adopted by all manufacturers, and (2) the uniform sales agreements between manufacturer, wholesaler and retailer, which were a part of the code. Administrator Allen advised that the radio manufacturers withdraw their code and apply to come in under the Electrical Manufacturers Code, submitted by the National Electrical Manufacturers Association (NEMA), which had already been approved by the President on August 5, and which went into effect August 16. The radio men were told that, while they were free to submit a revised radio code, there was grave danger that at a hearing objection would be raised and that there was little likelihood that any future code could be gotten through with wage provisions as favorable to the employers as those embodied in the NEMA code. Thereupon the RMA code committee withdrew its own code, and the RMA board of directors at a special meeting approved the application of the radio manufacturers to be included under the NEMA Electrical Code.

NEMA will administer code

The NEMA code fixes 36 hours as the maximum week's work in processing departments, and prohibits employment of any one under 16 years of age. For all other employees, except executives and traveling and commission sales people, a 40-hour week is prescribed. Minimum wages are fixed at 40 cents per hour, except in cases where the 1929 rate was less, but in no case shall the rate be under 32 cents per hour. Learners must be paid at least 80 per cent of the minimum, and the number of learners must not exceed 5 per cent. The minimum wage outside of processing employees must not be under $15 a week.

Administration of the code upon all radio manufacturers will be in the hands of an organization set up by the National Electrical Manufacturers Association, and the cost of such administration will be prorated among the radio manufacturers whether members

---

The portrait of Mr. Edison on the front cover has been declared the best photograph ever made of the great inventor, intent on a problem. It was taken at Dearborn, Mich., by the photographers of the Ford Motor Company.

RMA ACCEPTS NEMA CODE

NRA administrator turns down radio code.

Radio manufacturers put under electrical body

or non-members. It also seems likely that a Radio Section of NEMA will be formed, similar to the many other sections already set up among groups of manufacturers of various electrical specialties and supplies. If such a Radio Section is formed, its members will have the opportunity to draft a Radio Supplemental Code to the NEMA code, into which can be introduced special considerations bearing on fair practice and trade relations in the radio industry. The objections made by the NRA administrator to the RMA code will, however, apply to such future supplementary radio code.

An RMA committee to work out methods for the administration of the new Electrical Code under NEMA, has been holding conferences with the NEMA organization at the latter's headquarters, Commerce Building, 155 East 44th St., New York City. This committee comprises Arthur T. Murray, United American Bosch Company, James M. Skinner, Philco Radio & Television Company, and David T. Schultz, Raytheon Production Company.

After a plan of administration has been developed, it is expected that a meeting of the RMA board of directors and members will be called, to ratify the plan determined upon. Already a number of radio manufacturers who are also electric-refrigerator makers, are members of the NEMA, and it is expected that the others will also join. The future of the RMA organization itself was in some doubt as this issue goes to press. One group of members insisted on the importance of radio maintaining its separate identity; another group objected to paying dues to two associations, and recommended the dissolution of the RMA and the division of its assets among the members.

Following are some of the significant provisions of the NEMA Code:

"V. With a view to keeping the President of the United States and the administrator informed as to the observance or non-observance of this code and as to whether the electrical manufacturing industry is taking appropriate steps to effectuate in all respects the declared policy of the National Industrial Recovery Act, each employer shall, no less than once in each year, prepare and file with the board of governors or the executive committee of National Electrical Manufacturers Association an earnings statement and balance sheet in a form approved by said boards of governors or said executive committee or in a form acceptable to any recognized stock exchange. Each employer shall likewise prepare and file with such person or organization as the board of governors or the executive committee of National Electrical Manufacturers Association may designate and at such times and in such manner as may be prescribed, statistics of plant capacity, volume of production, volume of sales in units and dollars, orders received, unfilled orders, stocks on hand, inventory, both raw and finished, number of employees, wage rates, employee earnings, hours of work, and such other data or information as the board of governors or the executive committee of National Electrical Manufacturers Association may from time to time require."

No sales below cost

"IX. No employer shall sell or exchange any product of his manufacture at a price or upon such terms or conditions that will result in the customer paying for the goods received less than the cost to the seller, determined in accordance with the uniform and standard method of costing hereinabove prescribed, provided, however, that dropped lines, seconds, or inventories which must be converted into cash to meet emergency needs may be disposed of in such manner and on such terms and conditions as the supervisory agency may approve and as are necessary to move such product into buyers' hands, and provided further that selling below cost in order to meet existing competition on products of equivalent design, character, quality or specification shall not be deemed a violation of this article if provision therefor is made in supplemental codes for any branch or subdivision of the industry, which may be hereafter prepared and duly approved by the administration."

▼

The basic thermionic discovery, as described by Mr. Edison in his patent application of Nov. 15, 1883.

"I HAVE discovered that if a conducting substance is interposed anywhere in the vacuous space within the globe of an incandescent electric lamp, and said conducting substance is connected outside of the lamp with one terminal, preferably the positive one, of the incandescent conductor, a portion of the current will, when the lamp is in operation, pass through the shunt-circuit thus formed, which shunt includes a portion of the vacuous space within the lamp. This current I have found to be proportional to the degree of incandescence of the conductor or candle-power of the lamp."

▲

Loudspeaker cost vs. quality

By HUGH S. KNOWLES
Chief Engineer,
Jensen Radio Mfg. Company

A SURVEY of the speakers now manufactured shows that emphasis has been placed on small size as well as on low price. A practical discussion of the influence of cost on performance, therefore, becomes a consideration of the influence of size on performance. For the sake of brevity and concreteness, the average performance of a number of 5-inch ($3\frac{3}{4}$ in. piston) and 12-inch ($9\frac{3}{4}$ in. piston) speakers will be compared.

The principal criteria of loudspeaker performance are loudness efficiency[1], type of response and power handling capacity. The term "type of response" rather than "fidelity" is used because it appears that fidelity or exact reproduction of the original is seldom wanted. The emphasis is usually on bass response even though "synthetic" and on other characteristics which make the combined speaker and set sound like a radio and have consumer acceptance.

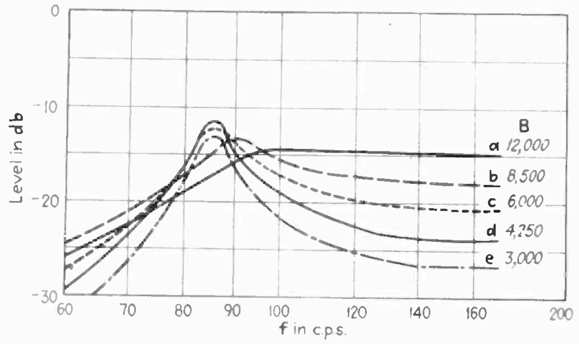


Fig. 1—Variation of output near resonance of good 12-inch speaker. Curve a represents fully excited field; curve d critical value of B for maximum output at resonance

Special emphasis is placed on loudness efficiency in inexpensive speakers because they are usually used with sets having limited electrical output. Of almost equal importance is bass response or an illusion of it. Here the small speaker is asked not only to overcome its own handicap as a sound radiator at low frequencies but to do it in a cabinet which affords very little effective baffle.

Loudness efficiency in small speakers is closely allied with fidelity. Many design considerations are common to both and to simplify the discussion, these will be treated jointly and only a few of the most important considerations discussed.

In considering loudness efficiency and fidelity, it is convenient to divide the response of the speaker into three ranges. These are:

(1) The resonant range from the lower cutoff to from 100 to 300 cycles depending upon the natural period of the system. (2) The piston range extending from (1) up to 600 to 1,000 cycles in the speakers here considered and (3) the high end or top extending from the first center moving mode to the upper cutoff frequency.

Calculations of speaker efficiency are most commonly made in the piston range because the assumptions which are made regarding radiation resistance, mechanical impedance, etc. hold closely and the performance can be accurately predicted. Unfortunately, the calculated efficiencies of two speakers in the piston range do not give an accurate index of their relative loudness efficiency. It gives values which are too low particularly in the case of inefficient speakers. This is due to the fact that the sound pressure in the piston range, measured on the speaker axis, is less than it is at the low and high ends. That is, inefficient speakers usually have a swayback characteristic as shown, for example, in Curve B, Fig. 7, where the dotted curve shows the low end measured in a large baffle.

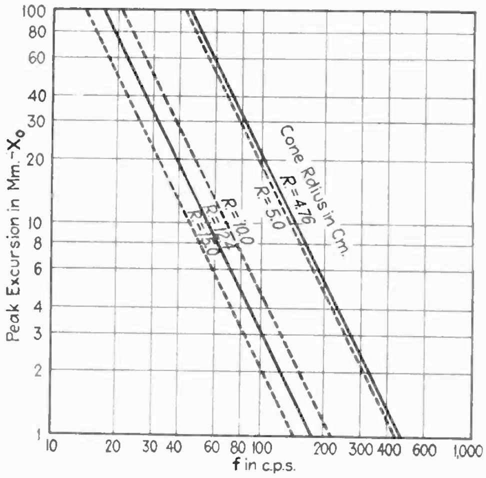


Fig. 2—Peak cone excursion as function of cone radius and frequency for 1 watt of sound output. The 5-inch speaker is curve R 4.76; the twelve inch is curve R 12.4

Hereafter we will use the terms "small, inexpensive and inefficient" interchangeably with the understanding that the terms apply to the present type of 5-inch speakers and to a lesser degree to slightly larger speakers. It is obvious, of course, that small speakers could be made much more efficient although at greater expense.

In an inefficient speaker the loudness efficiency is primarily controlled by the response in the resonant and high ends. In other words, the ear does not give much weight to the frequencies which lie in the limited piston range.

The factor *BL* (where *B* is the instantaneous average flux density the coil embraces in gauss and *L* is the length of conductor in centimeters if the c.g.s. system is used. *L* is, of course, a constant in any particular design) is the coupling factor between the electrical and mechanical circuits in a dynamic speaker. This factor has an optimum value just as it has in the analogous electrical case.

Figure 1 shows a family of curves of an efficient 12-inch speaker covering the resonant range for different values of B. The output at resonance actually increases as the flux density is decreased until the maximum is reached with a density of 4,250 gauss corresponding to curve *d*. This occurs after the efficiency in the piston range is dropped about 9 db. From this we can see that the optimum output at resonance is secured in relatively inefficient speakers. This accounts for the large rise in output at resonance in small speakers.

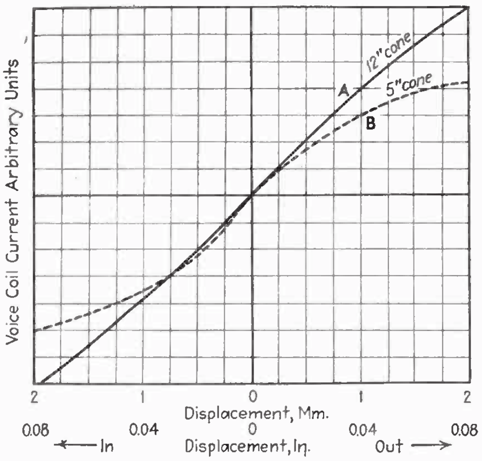


Fig. 3—Voice coil displacement curves. Note lack of symmetry due to difference in fringe flux and accounting for some even harmonic distortion

As the excitation is dropped, the high end is dropped fairly uniformly along with the piston range so that the speaker operating under conditions corresponding to curve *d* Fig. 1 has relatively more bass response than curve *a*. In curve *d* due to the small amount of damping, there is a large transient term so that there is considerably more response at and near resonance even though resemblance to the original wave form is entirely lost. This is especially true when the high amplitude low frequency signal is of short duration as is nearly always the case.

If the input to the speaker of curve *a* were attenuated 9 db below the input to that of curve *d* so that they had substantially the same output in the piston range and at the top, we would expect curve *d* to be louder because of the exaggerated bass response.

Curve *a* is for an ideal speaker in which the steady state and transient response do not vary with efficiency. In this case, if the efficiency in the piston range were lowered by say 6 db and the power input raised 6 db, the speaker would sound just as loud as it did originally. Curve *b* shows what occurs when the field excitation and piston efficiency are lowered. When the piston efficiency corresponds to curve *d* (down 12 db) for example, the input has to be raised 9.3 db to make it sound as loud as curve *a*. That is, the loudness efficiency has dropped only 9.3 db. These were run by listening 60 deg. off the speaker axis in a room with average absorption so the difference in highs did not mask the difference at the low end.

In getting the maximum loudness efficiency out of small speakers, designers have found empirically that the greatest loudness efficiency is obtained with thin top plates and voice coils only slightly longer than this thickness. We realize intuitively that the average flux density embraced by the voice coil cannot be constant when the cone moves appreciably in such speakers. This is verified by Fig. 3. These curves give the static relationship between voice coil current and cone displacement.

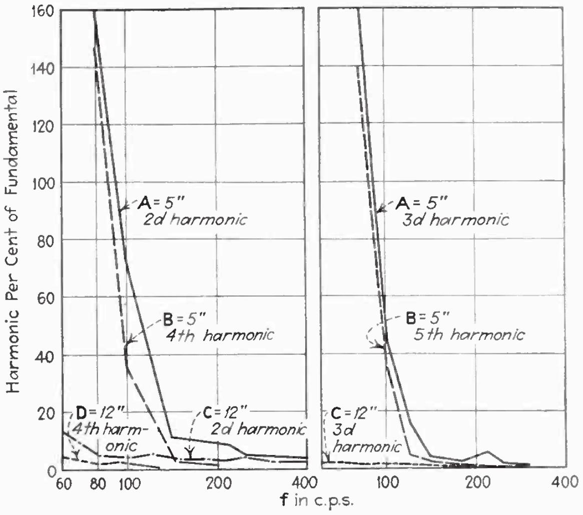


Fig. 4 and 5—Steady state distortion of several speakers (averaged). All curves were made with same sound output. Fifth harmonic of 12-inch speaker is negligible

These curves are composite curves which show the combination of the effect of the decrease in flux density, and hence force on the coil for constant voice coil current as the voice coil moves out, and the force displacement curve of the mechanical system. This shows that for the thin top plates commonly used considerable steady state distortion is to be expected if the excursion is large. The solid curve is for a 12-inch speaker with $\frac{3}{8}$ in. top plate and the dotted curve for a 5-inch speaker with $\frac{3}{16}$ in. top plate. The current is given in arbitrary units so that the slope at the origin could be made the same to simplify comparison.

An idea of the contribution of this factor to the steady state distortion may be gained by determining the peak displacement required at low frequencies. The power radiated from a speaker in an infinite baffle is[2]

$$W = \frac{4\pi^5 \rho R^4 f^4 X^2_0}{10^7 c}$$

where W is the sound output in watts, ρ is the density of air, R is the cone radius in cm., f is the frequency in cycles per second, c is the propagation velocity and X_0 is the peak excursion. Solving for X_0 we obtain

$$X_0 = \frac{4.78 \times 10^5}{f^2\ R^2}$$

From this we see that the excursion for constant output varies inversely with the square of the radius and, therefore, increases rapidly as the size of the diaphragm decreases. For the same sound output, the excursion of the 5-inch speaker cone ($R = 4.76$ cm.) is 6.8 times that of the 12-inch speaker cone ($R = 12.4$ cm.). Therefore considerable steady state distortion can be expected at low frequencies in a small speaker with narrow top plate and voice coil.

In practice, no attempt is made to reproduce very low

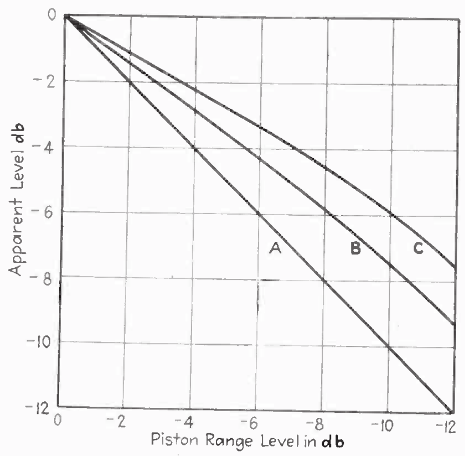


Fig. 6—Loudness efficiency as a function of field excitation and voice coil mass

frequencies with a small cone because of the large excursion requirements and because the speaker is used in a small cabinet where the radiation would be very small. The natural period is, therefore, usually put near the frequency for which the loss in pressure due to the small baffle is just about offset by the increase in pressure due to resonance. This tends to hold up the overall curve and still permits appreciable power to be radiated at resonance so that the transient distortion increases the apparent bass response.

Near critical values of *BL* the efficiency of a speaker may be high enough so that 1 watt or more is radiated at maximum input. The excursion is proportional to the square root of the power output so that for $\frac{1}{4}$ watt output these excursion values are halved.

The combination of all steady state distortion factors is shown in Figs. 4 and 5. These curves were both run in 3 foot baffles with large input transformers which gave little frequency discrimination and wave form distortion. The large baffle gives lower values of distortion for the small speaker because the fundamental is radiated better than it would be in a small cabinet. On the other hand, distortion curves show that when the small speaker is run with the usual "toy" input transformer, in spite of the transformer distortion, the total distortion below 100 cycles falls rapidly because there is practically no transmission and the cone excursion decreases.

Loudness efficiency criteria

Input was supplied from a distortionless triode amplifier at exactly the same level obtained at different frequencies when running the speaker out of a 43 type tube just below maximum output. The 12-inch speaker was then adjusted to give the same sound pressure and the distortion measured.

The effect of increasing the high frequency output of a speaker is to increase its loudness efficiency. The high frequency output is, in combination with other factors, increased by reducing the mass of the voice coil. In general, less efficient speaker designs require smaller voice coil conductor masses for optimum output. In inefficient speakers, the high frequency end can, therefore, be made better in proportion to the response in the piston range. If, therefore, the speaker efficiency is lowered by a change in design including a reduction in voice coil mass, the output may be relatively greater at the high end. In Fig. 6 curve C the efficiency of the speaker in the piston range has been lowered by altering the design in this manner. Here we note that due to the increased high frequency output the loudness efficiency drops less rapidly than it did in curve B. In fact, if the piston efficiency is lowered by 12 db, the loudness efficiency drops only 7.6 db. These figures are not, of course, exactly applicable to all designs. The exact difference will depend on the type of input (whether music or speech) and the frequency and power distribution of the input.

The amount of decrease in loudness efficiency is also complicated by such factors as the location of the natural period. For example, in a 5-inch speaker where the natural period is usually placed between 180 and 250 cycles, the loudness efficiency on *speech* will be much better than if this were dropped to say 80 cycles even though the baffle were large enough to permit radiation at this lower frequency.

The effect of the steady state distortion is to increase the apparent bass and loudness efficiency because the fundamentals of the lower frequencies are radiated poorly and the ear is more sensitive to the upper harmonics particularly at low levels.

In the case of sine wave excitation, the transient may be very large. In the case of the 5-inch speaker with a high natural period the amplitude of the transient due to a suddenly applied low frequency signal may be several times the amplitude under steady state conditions at this frequency. This transient further creates the illusion of bass response from small speakers.

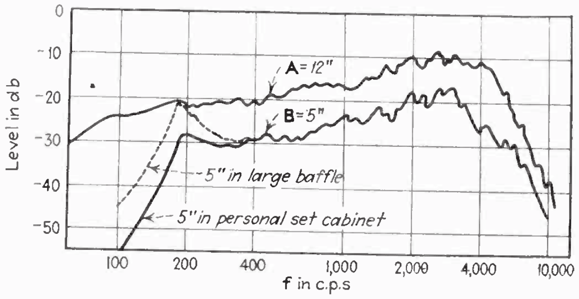


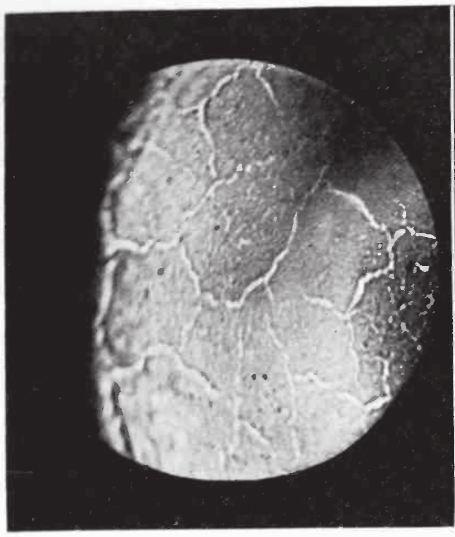
Fig. 7—Response of 5- and 12-inch speakers. Full curve B is small speaker in small baffle

Representative steady state frequency curves of 5-inch and 12-inch speakers are shown in Fig. 7. Advantage is taken of the small voice coil mass (in 5-inch speakers) to get considerable rise in the middle high range from 1,500 to 3,000 cycles. This gives fairly good articulation and some semblance of highs. The higher frequencies above 3,000 cycles are deliberately sacrificed partly to increase the peak at 3,000 cycles but principally because set distortion is less objectionable when this upper end is suppressed.

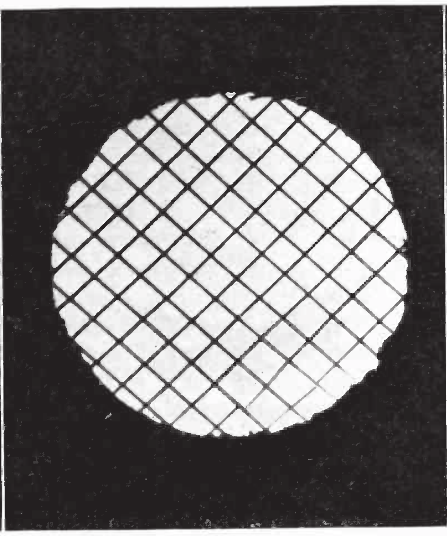
Power handling capacity

This leads us to the third important criterion of loudspeaker performance, namely, power handling capacity. This is improved by avoiding any sharp peaks in the high end which are accompanied by objectionable transient distortion and by lowering the high frequency cut off. When a set designer asks for a speaker which will "take it," that is, show minimum distress with the gain control wide open, he invites a speaker of this type. Many tests have shown that lowering the high frequency

[*Please turn to page 256*]



High emitting cracks of thick oxide coated cathode in gas discharge magnified 100 times



Molybdenum wire grating taken on a gilded glass screen. Velocity of electrons, 70,000 volts, spacing 0.3 mm.

Bright spot in cathode obscured by space charge in front

The electronic microscope

By M. KNOLL

As long ago as 1927 theoretical studies indicated that the deflecting coil in a cathode ray tube must be the equivalent of a lens acting on light rays, and accordingly the diameter of the electron focus, i.e., the smallest ray-diameter adjustable on the luminous screen (d_s) depends only upon the diameter of the electron source (d_k). Therefore the distance of an object a and the distance of the picture b from the coil must follow the well known optical law $d_s = d_k\, b/a$.

Starting with this assumption the thought immediately presents itself that by decreasing the object distance enlarged images of a small object might be projected on a luminous screen provided the object emits electrons or is illuminated with electrons. This would constitute an electronic microscope.

The above law was proved within a precision of 5 per cent over wide ranges of a and b. The quality of images on a fluorescent screen focussed by magnetic coils was equal to that of good glass lenses. Furthermore electronic images could be produced by electric fields symmetrical to the ray axis and with systems composed of magnetic condensing and electric dispersing lenses, etc. For example if two magnetic lenses with an intermediate image plane are used, the direction of rays is identical to that of the ordinary projecting microscope. It was found that chromatic aberration could produce considerable distortion in the images; if, however, the velocity of electrons is homogeneous enough these errors can be neglected. The spherical aberration was below the limit of observation in the apparatus constructed.

It was not difficult to construct a practical electronic microscope (see page 258 this issue) for the 10 to 80 kv. range. It is a gaseous discharge tube. The figures show the precision of the image to be comparable to that of an ordinary microscope of the same enlargement.

Studies of cathode surfaces

The method was also thought useful to study the emission and the change of surface of oxide-coated cathodes under variable conditions and to observe the burn-out of oxide-coated cathodes, or the electron space-charge in front of a hot cathode. A microscope of smaller dimensions was then constructed especially for research at lower voltages (200 to 2,000 volts). After initial difficulties, caused by the inhomogeneity of the electric field of the emitting surface, perfectly sharp and undisturbed images (up to 100 times enlarged) could be obtained.

The enlargement so far attained is about 1:400. In the present arrangement this is due to the sensitivity of the apparatus to the movement of the mercury in the vacuum-pump. For technological investigations enlargements on smaller scale are sufficient; for physical investigations we hope to make further progress to increase the intensity of electron rays and furthermore to enlarge the electronic image on the fluorescent screen by means of an ordinary microscope. The limit of dissolving power of any microscope depends theoretically on the wave-length of the used radiation; therefore the dissolving power of the electronic microscope depends on the De Broglie wavelength of the electrons which is for electrons of 2,000 volts about 10,000 times smaller than that of light waves. Thus, theoretically, microscopic structures can be dissolved which approach the diameter of molecules even using a much smaller aperture than in ordinary microscope. How far this extremely high dissolving power can be obtained practically cannot be decided at present. In any case the further development of the electronic microscope and its methods will be of great importance for the technique of vacuum-tubes and for the physics of the gaseous discharge.

Electron emitting alloys of nickel and barium

By D. W. RANDOLPH,
O. S. DUFFENDACK and R. A. WOLFE
A C Spark Plug Company and University of Michigan

THE development of stable alloys of nickel and barium that have electron emitting properties is of interest because of their adaptability to use in vacuum tubes. The experimental work with these alloys for the severe service encountered in spark plug electrodes has been described[1]. The purpose of the present article is to give in more detail the characteristics of interest in vacuum tube work.

A curve showing the relation between the barium content of the alloy and the thermionic emission as measured under conditions standardized for the experiments is given in Fig. 1. The thermionic emission was used as an index of the work function of the extraction of electrons from the wire, and, as is shown by the curve, a very small percentage of barium greatly increases the thermionic emission. Experiments were made to determine to what extent the percentage of barium could be increased and what were the properties of the resulting alloys. The first developments resulted in the production of alloys containing small amounts of barium, from 0.02 per cent to 0.20 per cent. These are now produced on a commercial scale. Later work has resulted in alloys containing up to 10 per cent barium. The purpose of the present paper is to describe the properties of these alloys in the lower percentage range and modifications of the alloys that are of interest because of their adaptability to use in vacuum tubes, glow tubes, and the like.

The first series of alloys had a composition of approximately 98 per cent nickel, 0.5 to 2.0 per cent manganese, and .08 per cent to .25 per cent barium together with traces of carbon, iron, and silicon as impurities. The alloys are produced in a 35 kva. Northrup high frequency furnace in carbon-free crucibles. Close temperature control is maintained by a Leeds and Northrup optical pyrometer occasionally checked by a standardized platinum-platinum rhodium thermo-couple. The molten metal is thoroughly degassed before the addition of the barium and poured into heated steel molds provided with refractory "hot tops" to assist in the pouring and to provide an escape for gases driven from the ingot as the metal cools. The cast metal is clean and bright and sections cut from the ingot are not attacked by water, showing the absence of free barium. Whether these mixtures are true alloys or not is not yet known for the higher percentage range, but in the lower range, apparently true alloys are formed. The distribution of barium throughout the metal is very uniform and no measurable variation in the composition of samples cut at random from large coils of wire is found, nor is there any segregation detectable under the microscope. The alloys are resistant to corrosion at elevated temperatures both from atmospheric gases and sulphur dioxide. The barium used is produced by the process described by Guntz[2], and is carefully handled to avoid the formation of oxides and nitrides.

The samples with which these tests were made were hot rolled to one-fourth inch round rods at a rolling temperature of approximately 1900° F and wire was cold drawn from these rods to the finished sizes. The majority of laboratory tests were made on wire 0.072 inch in diameter, although samples of fine wire and of ribbon were also made for vacuum tube tests. The finished wire was analyzed chemically for important elements, and the barium content was checked by the spectroscopic methods developed by Duffendack and Wolfe[3] These spectroscopic determinations were especially useful in checking the finished alloys to make sure that no undue segregation of any of the elements had taken place.

Numerous specimens of the alloys have been tested for thermionic emission. The current recorded is the emission current from approximately one square centimeter of surface at a temperature of 1050° C. The alloys were found to give steady electron currents over long periods of time, provided a temperature of 1000° C. was not exceeded. If the filaments were operated at higher tem-

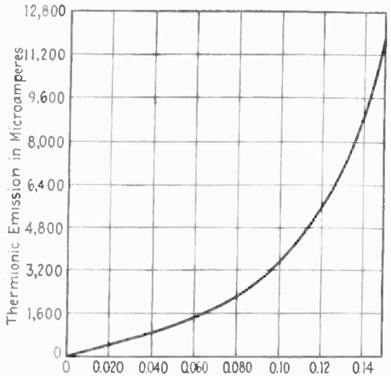


Fig. 1—Relation between barium content and emission

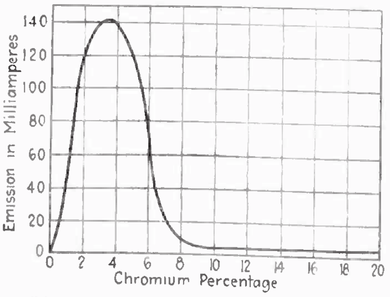


Fig. 2—Effect of chromium on electron emission

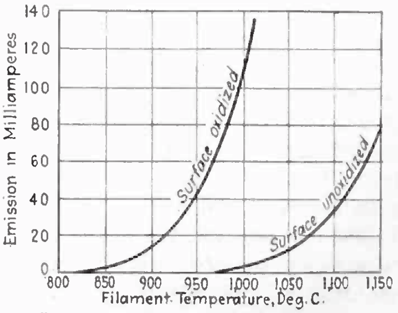


Fig. 3—Importance of oxidizing filament surface

TABLE I

Alloy No.	Ni	Mn	Ba	Cr	C	Impurities	Emission in Milliamperes	Remarks
518	96	2.03	.062	2.0	.164	......	29. at 1050°C	Emission rapidly decreases with time
469	96	2	.072	...	...	2.0 Co	2.1 at 1150°C	Very heavy evaporation
263	95.5	2	.190	...	...	1.52 Fe	1.3 at 1150°C	Heavy evaporation—Compare emission with No. 420
420	94.0	2	.144	1.99	...	......	180.0 at 1050°C	Very little evaporation
576	93.0	2	.09	4.0	...	1.0 Si	82.0 at 1150°C	Quite heavy evaporation

peratures, the alloy evaporated and the active surface was destroyed. The original emission could be restored by maintaining the filament at a lower temperature again for a time as the barium diffused to the surface from the interior of the wire.

The first measurements on the thermionic emission from barium-nickel-manganese alloys failed to show a regular variation of the electron current with the barium content. Detailed spectroscopic and chemical analyses revealed the presence of small amounts of impurities that had relatively large influences on the thermionic emission. Among the impurities invariably found to be present, though in varying amounts, are carbon, iron, and silicon. Titanium and additional amounts of the others were added to study the effects of their presence. Carbon, iron, and silicon when present in amounts more than mere traces increase the rate of evaporation of the alloys. Rapid evaporation is detrimental to the stability of the electron emitting surface of the filament, and, as a consequence, the alloys that evaporated rapidly were found to give decreasing thermionic electron currents. Iron and titanium apparently affect the work function of these alloys adversely, as those in which these elements were present gave lower thermionic currents for a given percentage of barium than alloys which did not contain them. To illustrate these effects, Table I gives the results of measurements on a number of specimens containing approximately the same amount of barium and varying amounts of some of the elements mentioned.

The rates of evaporation of the several alloys were determined qualitatively by observing the accumulation of metallic films on the walls of the vacuum chamber in which the filaments were mounted for measurements on thermionic emission. All of the alloys in this series evaporated somewhat at temperatures above 800° C. The films were examined spectroscopically and contained all of the elements of the alloy. The films were relatively richer in silicon and manganese than the alloy showing that these elements evaporated at a somewhat higher rate than the others. Especially is this true of silicon. The change in the composition of the alloy through evaporation was, however, very slow. The effect of small percentages of chromium on the rate of evaporation of these alloys is especially important and will be discussed later. When added in small amounts, it very materially decreased the rate of evaporation. Carbon in excess of approximately 0.05 per cent, iron in excess of .25 per cent and silicon in excess of .20 per cent markedly increase the rate of evaporation.

The maximum rate of thermionic emission from the nickel-barium-manganese alloys at temperatures that can be maintained over long periods of time without detriment to the alloy is not great enough to permit of their use for uncoated filaments in electron tubes. As a base metal for oxide coated emitters, however, these alloys have certain definite advantages. A series of experiments on the use of these alloys containing 0.15 per cent barium as a base for oxide coated filaments in commercial vacuum tubes was reported by Beese[4] who concluded that the small continuous supply of barium from the core metal produced a more active source of electrons than is the case where the coating alone furnished the barium. With thick oxide coatings, the barium alloy filaments attained an emission about 70 per cent larger than did those with pure nickel cores. With light coatings of oxides, the activity of the barium alloy filaments was comparable with that of pure nickel bearing a heavy coating and the life of the alloy filaments was normal.

A still more stable alloy than the nickel-barium-manganese alloy was desired for use for spark plug electrodes. It was found that the addition of chromium in certain percentages produced marked beneficial results, and the electron emitting characteristics of such alloys was investigated. The addition of chromium produced an appreciable effect on the thermionic emission from the alloy, the amount being dependent upon the percentage of chromium in the alloy. Figure 2 shows the emission observed from a series of alloys with the same amount of barium and with varying percentages of chromium. It will be observed that the electron emission increases with the amount of chromium to a maximum at 3.5 per cent chromium and then decreases again.

TABLE II

	Nickel	Ni-Mn-Ba	Ni-Mn-Cr-Ba
Barium content	0	.08-.15%	.08-.15
Electron emission per sq.cm. at 1150°C	....	7.5-20.0 m.a.	140.0 — space change limited
Electron emission per sq.cm. at 1050°C	....	......	18.0-180.0 m.a.
Resistivity — ohms/Cm³	10-12	12-14	40-42
Temp. coef. of resistance ave. 20°C-900°C	.0040	.0046	.00063
Strength of .072 in. dia. wire			
At 20°C — lbs/sq.in	60,000	70,000	70,000
At 800°C — lbs./sq.in.	8,000	8,800	12,000
Melting point	1454°C	1430°C	1420°C
Evaporation temp.(*)	....	850°C	1050°C

* This is the temperature at which the rate of evaporation becomes serious enough to affect the electron emission of the heated filament. Below this temperature the rate of evaporation is so slight that the walls of a glass container are not perceptibly darkened in 100 hours.

The addition of chromium was found to be beneficial in other ways as well as in increasing the thermionic emission. The alloys containing chromium are more resistant to corrosion and have greater tensile strength, especially at temperatures of 800-900° C. The electrical resistivity of the chromium alloys is greater than that of those not containing chromium which makes it necessary to increase the cross section of filament wires in order to give them the same voltage rating. Whether this is an advantage or not depends upon the design of the tube, but in some cases it is an advantage because of the increased area of the emitting surface. The rate of evaporation of the alloys containing from 1 per cent to 7 per cent of chromium was found to be markedly less than that of alloys without chromium and less than pure nickel. This low rate of evaporation permits the maintenance of a very stable emitting surface for a long period of time, and this is a decidedly advantageous feature in many electronic tubes.

TABLE III

Barium content	0.44 per cent
Electron emission per sq.cm. at 810°C	100 m.a.
Resistivity	24 microhms/Cm³
Melting Point	1420°C
Evaporation temperature (*)	850°C

*Temperature at which the rate of evaporation becomes large enough to effect the electron emission of the heated filament.

It was found that a very stable emitting surface with a higher rate of electron emission could be formed on the chromium alloys by producing a light surface oxidation. A very thin film of oxide was formed by the heating of the filaments in air or other oxidizing atmosphere for a few seconds to a temperature of about 850° C. A slight discoloration of the surface is observed when the oxidation has proceeded to the right point. The emission from an alloy containing 4 per cent chromium and 0.10 per cent barium was found to be increased 50 fold at a temperature of 1000° C. by this treatment. The active surface is very stable at temperatures up to 1100° C. and the electron emission rate is remarkably constant over long periods of time. Figure 3 shows a comparison of the thermionic currents from an oxidized chromium alloy and the same alloy unoxidized.

As a base metal for oxide coated emitters, the chromium alloys have proved to be very satisfactory. When the surface of the alloy is oxidized slightly before the application of the oxides, the coating is found to adhere very tightly and uniformly, and the low evaporation rate insures the stability of this adherence. These alloys are especially free from gas and can be produced with great uniformity of composition.

The characteristics of the two alloys described in this paper that are now available on a commercial basis are given in Table II. The constants for pure nickel are given for comparison.

In addition to these alloys of relatively low barium content, a number of nickel-barium alloys are now under test containing considerably larger amounts of barium. Methods of alloying and working this metal are in process of development, and such tests as are in progress show the possibility of the production of a uniform alloy of high electron emitting properties. Certain specimens of that series have been drawn into sizes such that measurements on the thermionic emission could be conveniently made. Typical data on this alloy appear in Table III. It will be noted that the thermionic emission per sq. cm. is of the same order of magnitude as that from oxide coated emitters.

A filament of this alloy was used to maintain a low voltage arc in CO. An arc current of 15 m.a. at 180 volts was maintained for over 200 hours. This performance indicates that the emitting surface can withstand considerable positive ion bombardment.

[1] O. S. Duffendack, R. A. Wolfe, and D. W. Randolph Trans. Electrochem. Soc. LIX, 1931; 181-198.

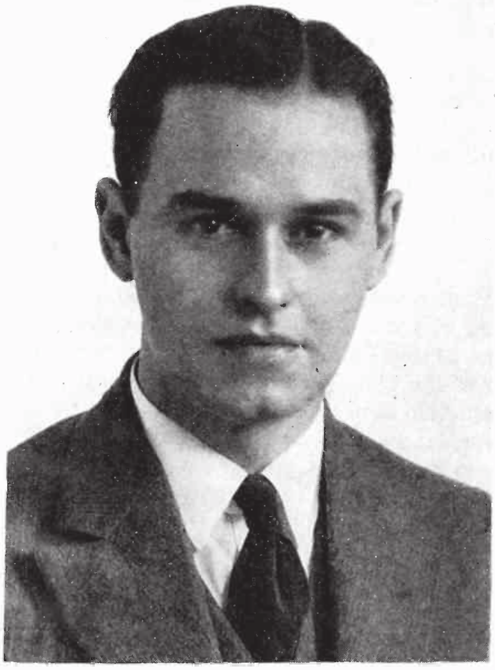
[2] Guntz-Bull. Soc. Chim. 29, 1903.

[3] Duffendack and Wolfe, *Physical Review* 40, Po.1038/1932

[4] Thermionic Emission of Oxide Coated Cathodes Containing a Ni-Ba alloy core, N. C. Beese, *Physical Review* 36 Pa.1309, 1930.

The Code and the Engineer

AMERICAN RADIO MANUFACTURERS are now operating under a "Code of Fair Competition for the Electrical Industry" which was approved by President Roosevelt on August 4. In the necessarily broad regulations thereby established for this highly ramified industry there is no formal recognition of that select class of professional laborers to whose creative effort the principal commodities of every radio manufacturer owe their origin. There exists, nevertheless, a vital connection between the corporate welfare of every radio manufacturer and the productivity of his engineering employees. Unless the teachings of industrial history are mockery, the radio industry will be distinguished for years to come by an essential dependence upon inventive thought, both technical and artistic. Periods in which this industry has provided large employment for labor and legitimate return on invested capital have always been preceded by exceptionally productive engineering activity. The recurrence of this sequence has been too consistent to suggest anything but a causal relation.



By Dr. L. M. Hull, President,
Institute of Radio Engineers

A choice is now presented squarely to all radio engineers and their employers: whether to revive conditions favorable to *inventive* engineering efforts or to continue with price-lowering as the main objective of engineering thought. Such a revival would provide sufficient centrifugal force to throw the industry out of the vicious competitive circle in which it is now spinning. Competition in ideas, rather than competition in prices, is still a sane and profitable activity. Furthermore, this revival of creative engineering is the most direct means of reconciling the Government's requirement of sustained highly-paid employment with that renewed effectiveness of invested capital which is vital to the industry. Recognition of this principle is an obligation to be shared alike by engineers and by their employers, in striving toward that rehabilitation of the industry which we all confidently anticipate.

Rectifier for modulation measurements

By J. L. POTTER
State University of Iowa

In making modulation measurements by an oscillograph it is necessary to rectify the envelope of the carrier wave. If the oscillograph is to give an exact reproduction of what is happening in the transmitter, the rectifier must have a linear characteristic between the impressed voltage and the output current.

An attempt was made to find a tube which approached the linear characteristic very closely. Such tubes as the 280, 281, 866, 82, and some power amplifiers were tested. Of this group the 280 was found to be the most satisfactory. The two plates were connected together and the tube used as a half-wave rectifier. The distortion was found to be less than 2 per cent when used properly.

Figure 2 shows the curves of the 280 tube when various values of resistance R were placed in series with milliammeter I and the C battery voltage is zero. The more resistance added, the straighter the curve will be; but more power is necessary to obtain a given deflection of the meter or oscillograph, which fact is a disadvantage when making modulation measurements on a transmitter. Figure 2 also shows the relation between the distortion and the resistance R.

The per cent distortion was calculated by the same formula that is used in calculating the per cent distortion in power tubes. Per cent distortion =

$$\tfrac{1}{2}(I_{\max} - I_{\min}) - I_o/(I_{\max} - I_{\min})$$

When calculating the per cent distortion $I_{\min}$ must be the current when E is zero and $I_{\max}$ is the maximum current necessary to give good deflection on the oscillograph and I_o is the current value corresponding to E_o, where $E_o = E_{\max}/2$

From Fig. 2 it is evident that most of the distortion occurs at the lower values of voltage. This distortion as far as modulation measurements are concerned may be eliminated to a certain extent by putting in a battery to supply a small voltage which will cause a small d.c. component of current to flow through the oscillograph element. The d.c. component of current will cause a constant shift of the oscillograph element, but this may be returned to zero by adjustment of the oscillograph.

Figure 3 shows the curves taken for three different values of battery voltage when R is 1000 ohms. Curve 3 of Fig. 2 is for zero C battery and R equals 1000 ohms. If the above precautions are taken, a rectifier can be had which has less than 2 per cent distortion.

When the modulation reaches 100 per cent the voltage must reduce to 0 and also increase to twice its normal value; hence, the total curve is put to use.

If the modulation is less than 70 per cent it will not be necessary to use the C battery.

Figure 4 shows the circuit diagram of the rectifier as used on an oscillograph for modulation measurements. Two 280 rectifier tubes with plates connected together are used to make a full wave rectifier. The purpose of connecting the plates together is to keep the a.c. plate resistance as low as possible. The filament battery is used for part of the bias voltage, the additional voltage being supplied by the 4,5-volt C battery. The pick-up coil is a bank-wound coil with 30 turns center-tapped, connected to the tubes by a three-wire flexible cable.

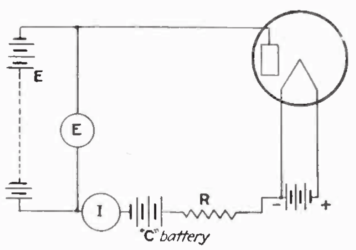


Fig. 1 — Circuit for determining rectifier characteristic

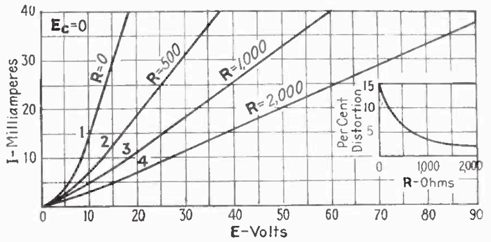


Fig. 2—Characteristic and distortion of rectifier for various loads

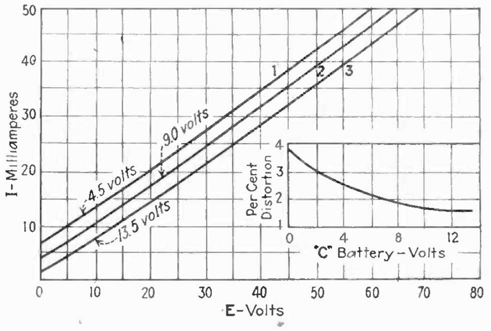


Fig. 3—Effect on distortion of using C batter on rectifier

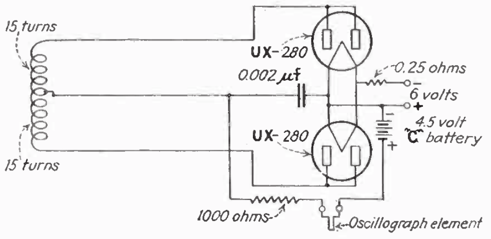


Fig. 4—Double-wave rectifier for oscillograph

The phantom tester

A method of testing high power mercury vapor tubes

By D. D. KNOWLES AND
C. E. HALLER,

*Westinghouse Elec. & Mfg. Company
East Pittsburgh, Pa.*

THE development of high power mercury vapor rectifiers, Ignitrons and grid-controlled tubes has brought with it many problems in connection with the manufacturing and testing of the product. For example, to test the Westinghouse Grid-Glow Tube DKU-622 would require at least a transformer rated at 75 amperes and 30,000 volts, or 2250 kva. To control this voltage, an induction regulator or other control equipment would be needed. The energy would have to be dissipated in a huge resistor bank or else expensive converter equipment would be required to feed the energy back into the lines.

The latter is very difficult to do inasmuch as tests are often carried to destruction of the tube and the resulting surges and other disturbances necessitate very elaborate protective equipment. In event the energy is dissipated in a resistor, the cost for electricity alone may amount to something like $20 to $60 per hour, depending on the unit cost of power. At this rate, to season a tube for several hours, as is often desirable becomes almost prohibitive.

A solution to this problem has been sought by others.[1]

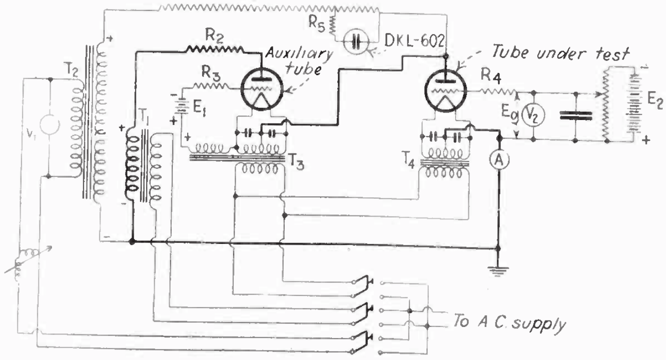


Fig. 1—Circuit of the "phantom tester" for determining the performance of large mercury vapor tubes

In general circuits fail to duplicate all the conditions of actual use, either by not applying rated inverse voltage following current conduction or by failing to apply rated forward voltage following the inverse half cycle. The authors, therefore, are not aware of any circuit that has been as effective as the one in use at the Westinghouse Research Laboratories for the last year or more. This circuit was designed primarily for the testing of Grid-Glow tubes and its operation is based on certain known characteristics of the tubes.

Theory of the circuit

Unlike a simple rectifier, a grid-controlled tube must be able to block a certain voltage in the *forward* direction as well as in the *inverse* direction. This requires the application of both halves of the high voltage wave to test the two conditions.

In either case, it is further recognized that only comparatively small currents can flow without forming an arc, which on the inverse half cycle constitutes what is called an arc-back and on the forward half cycle means loss of grid control. The significance of this fact is that, provided other conditions in the tube are normal, the high voltage transformer does not need to have a high current carrying capacity. For example, it may be rated at 1 ampere and 30,000 volts or 30 kva. instead of 2250 kva.

The tendency to arc back, and to a lesser extent, the tendency to lose grid control depends considerably on the amount of current passed on the previous conducting half cycle, both as it affects residual ionization and the temperature of the tube. It is, therefore, essential that the rated value of current be allowed to flow on each conducting half cycle.

Inasmuch as the drop across the tube, and hence the heating and ionization produced, depend only on current, it matters not whether the current comes from a high or a low voltage source. For economy then this current can be supplied from a low voltage transformer, say one rated at 75 amperes and 220 volts or 16½ kva. This results in a total power capacity of 46½ kva. instead of 2250 kva. as would be required under actual full load conditions.

Method of operation

The problem reduces then to one of applying rated forward and inverse voltages from a low current source and then, once the tube has started, allowing rated current to follow through from a low voltage source during the remainder of that half cycle.

The circuit shown in Fig. 1 contains two principal current paths:

1. *The high voltage path* starting from the secondary of transformer T_2 through resistance R_1 to the tube under test and from the cathode of this tube back to the opposite side of the secondary of T_2.
2. *The low voltage path* starting from the secondary of transformer T_1 through the resistor R_2 to the anode of the auxiliary tube; from the cathode of this tube to the anode of the tube under test and then from the cathode of the latter to the other side of the secondary of T_1. The transformers T_1, T_2 and T_3 are phased as indicated by the + signs on the secondary windings. During the conduction half cycle, the anodes of both the auxiliary tube and the tube under test are positive as is also the grid of the auxiliary tube. The latter, therefore, is biased to start at a low voltage and consequently

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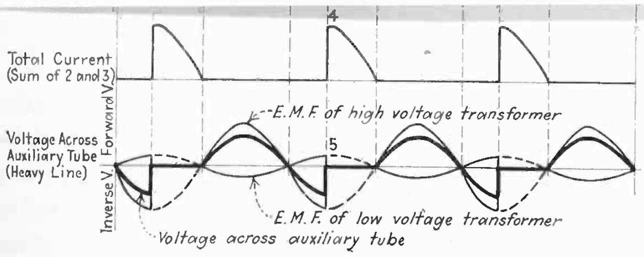

Fig. 3—Current and voltage relations in the high power tube testing circuit

to feed the desired current through the tube under test as soon as it starts.

If now the bias voltage E_g is reduced gradually from a high negative value, the tube under test will start first at the peak of the high voltage wave. This instantaneous value of voltage and the corresponding value of critical grid voltage gives us one point on the conventional control characteristic shown in Fig. 2. As the bias is still further reduced, the tube starts earlier in the cycle and in each case the desired current follows through from the low voltage path. The actual current through the tube is, of course, the sum of the currents from the two paths.

Fig. 3 shows graphically the current and voltage relations in the circuit.

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On the forward half cycle of test voltage, arc backs in the auxiliary tube might occur. If this happened, the forward voltage would be removed from the tube under test and it would be assumed erroneously that the grid of the latter was blocking the high voltage. To avoid this error, an arc back indicator can be placed also in the anode circuit of the auxiliary tube.

In conclusion the authors wish to point out that while the phantom tester has not been proven absolutely to be the equivalent of actual conditions, there has not been a single instance, out of several hundred tubes tested, to indicate otherwise. In other words, tubes that show a tendency to arc back on the tester at a given inverse voltage have actually always developed arc backs at that same voltage in a power circuit with similar characteristics. Obviously if the power circuit affords less time for deionization than the test circuit, it may arc back at a lower voltage. This, however, is another matter, concerning deionization, or rate of recovery of dielectric strength after current extinction and does not come within the scope of the present paper.

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[1] "*Cheater Circuits*" by J. L. Zehner, *Electronics*, July, 1932, page 224.

The pha

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A method of
power mercury

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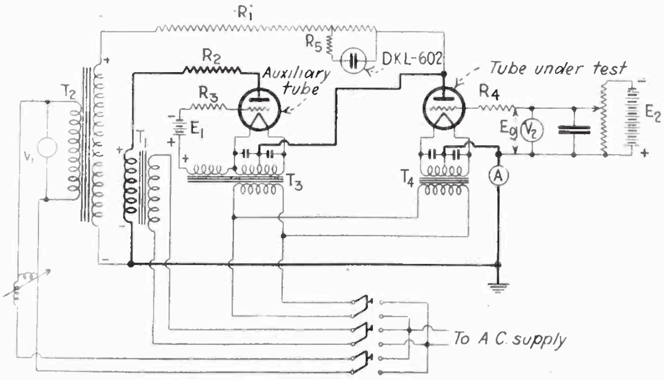

Fig. 1—Circuit of the "phantom tester" for determining the performance of large mercury vapor tubes

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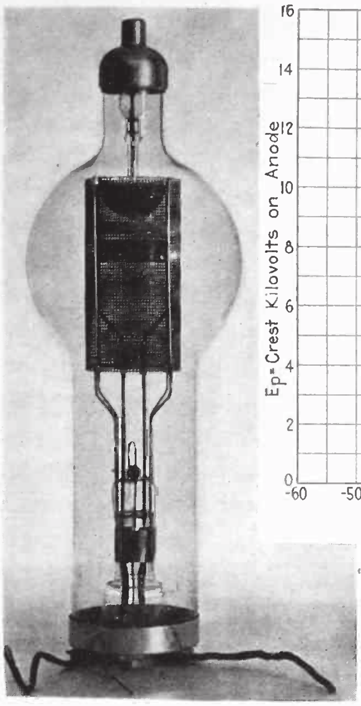

Fig. 4—Grid-glow tube DKU-623, a high powered controlled rectifier

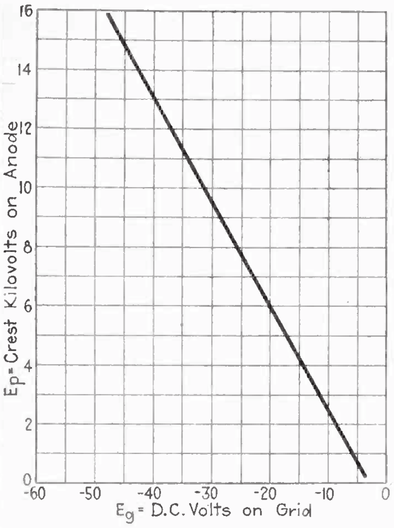

Fig. 2—Control characteristic of the DKU-623 rated at 25,000 volts, peak, and 25 amperes, average. It is a grid-controlled rectifier

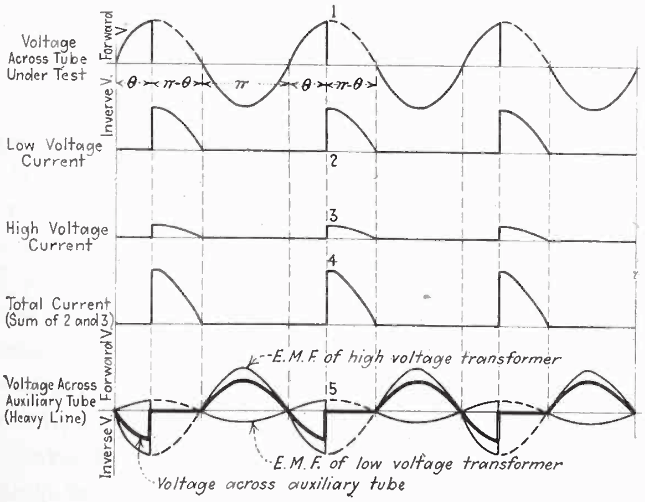
Voltage Across Tube Under Test
Forward V.
Inverse V.
θ
π-θ
π
θ
π-θ
1
Low Voltage Current
2
High Voltage Current
3
Total Current (Sum of 2 and 3)
4
Voltage Across Auxiliary Tube (Heavy Line)
Forward V.
Inverse V.
E.M.F. of high voltage transformer
5
E.M.F. of low voltage transformer
Voltage across auxiliary tube

Fig. 3—Current and voltage relations in the high power tube testing circuit

to feed the desired current through the tube under test as soon as it starts.

If now the bias voltage E_g is reduced gradually from a high negative value, the tube under test will start first at the peak of the high voltage wave. This instantaneous value of voltage and the corresponding value of critical grid voltage gives us one point on the conventional control characteristic shown in Fig. 2. As the bias is still further reduced, the tube starts earlier in the cycle and in each case the desired current follows through from the low voltage path. The actual current through the tube is, of course, the sum of the currents from the two paths.

Fig. 3 shows graphically the current and voltage relations in the circuit.

Wave 1 shows the voltage across the tube under test for the condition when starting occurs at the peak of the cycle.

Wave 3 shows the current from the high voltage source and wave 2 that of the low voltage path.

Wave 5 shows the voltage across the auxiliary tube for both the forward and inverse potential conditions.

From this figure it will be noted that the auxiliary tube must have certain definite characteristics:

1. During the forward or normally conducting half cycle of the tube under test, the auxiliary tube must be able to withstand, in the *inverse direction,* the full peak of the high voltage minus the practically negligible peak of the low voltage.
2. It must, of course, be able to pass as much current as the tube under test.
3. During the inverse cycle the grid of the auxiliary tube must be able to block in the *forward direction* the peak of the high voltage wave minus the peak of the low voltage wave. This is accomplished automatically by the reversal of grid bias supplied by the secondary of T_3.

Interpretation of test results

To adequately analyze the various types of failure that may occur either in the tube under test or in the auxiliary tube, several special devices have been introduced.

During normal operation, any current flow through the resistor R_1 will always be from left to right in the diagram. Consequently a cold cathode neon glow lamp, such as the DKL-602, connected across a portion of the resistor R_1 will glow only on one electrode, the one on the right.

On the inverse cycle of test voltage either one of two failures may occur:

1. The tube under test may arc back.
2. The auxiliary tube may fail to block.

In either case current would pass through R_1 from right to left, thus giving a visible flash on the normally dark electrode of the glow lamp. A dependable arc back indicator in the circuit of the tube under test, for example at A, would indicate if this tube had arced back while a flash on the glow lamp without such an indication would mean a failure of the auxiliary tube to block. The latter must, of course, be guarded against because it removes the inverse potential from the tube under test.

On the forward half cycle of test voltage, arc backs in the auxiliary tube might occur. If this happened, the forward voltage would be removed from the tube under test and it would be assumed erroneously that the grid of the latter was blocking the high voltage. To avoid this error, an arc back indicator can be placed also in the anode circuit of the auxiliary tube.

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electronics

McGraw-Hill Publishing Company, Inc.
330 West 42d Street
New York City

O. H. CALDWELL, *Editor*

Volume VI —SEPTEMBER, 1933— Number 9

Russia's high-power broadcast stations

DR. LOUIS COHEN, of Washington, D.C., consulting radio engineer, who returned recently from Russia, reports that the Soviet Government now has in operation one 500,000-watt broadcast transmitter and five 100,000-watt broadcast transmitters as well as 50 to 60 stations ranging from 2,000 to 25,000 watts. The advisability of building a 1,000-kw. station is also under consideration.

Three million radio receiving points are now available and it is expected to increase these to 20,000,000. Receiver production is now going on at the rate of 200,000 annually; with plans under way to increase set production to 1,500,000 annually.

Shoddy automobile radio sets

IT IS no secret that the editors of *Electronics* decry the manner in which shoddy radio sets have been sold to the depression-ridden public under the guise that the merchandise is merely low-priced and therefore in keeping with the times.

It is freely admitted that small sets, even cheap sets, may inoculate with the joys of radio reception a portion of the public otherwise deprived of receivers, or that in time this public will return for better merchandise.

But we view with alarm the mounting tide of shoddy automobile radio sets selling at such low prices they attract many buyers, many of whom are doomed to disappointment. Complaints received in a single week on one of the cheap sets bearing a well known name, involve lack of sensitivity, excessive vibrator trouble, speaker rattle, mounting difficulties, blown condensers, poor soldering, loose rivets in vibrator mounting, oscillation, instability, and critical operation as regards tubes. Of this particular set, widely advertised, an experienced dealer in the Northwest said, "we have had more trouble with this receiver than with any other model in our experience."

This indicates not only cheap merchandise but receivers shoddy in electrical and mechanical equipment and workmanship.

The fortunate failure at Mexico City

THE North American Radio Conference at Mexico City has broken up, after agreeing only on such obvious principles as 10-kilocycle separation, 5-cycle maximum deviation, interference elimination, and so on.

But on the vital topic of the allocation of broadcasting channels as between nations of the conference, no progress was made—or could be made. The demands of the other countries were excessive, out of reason, and based on no logical principle or premise, except national pride. The American delegation did well to move to adjourn, and close the sessions. Judge Sykes deserves the congratulations and admiration of every broadcaster and every listener for this prompt and patriotic action. Now for a while at least, the broadcasters can breathe easily, as the spectre of a new broadcast allocation recedes.

In their conferences at Mexico City the U. S. delegates were embarrassed by the anti-U. S. activity of several Americans. An American educational group actually distributed among the foreign delegations, propaganda injurious to the American position. And a former Vice-President of the United States attended the conference as "observer" for a high-power pirate station on Mexican soil!

A bed-side radio

THE admirable purpose of having "a radio set in every room" has now achieved such proportions in some homes, that when several members of the family are tuning in their different favorite programs, the resulting Babel is intolerable. A return to headphone or "pillow" radio on some of the sets in such a home would be a welcome relief.

Some smart manufacturer of cigar-box radios will probably shortly make this feature available by providing his little set with a cut-off jack, so that a head-phone unit can be plugged in, at the same time cutting out the loudspeaker. The little set will then become a true bedside radio, capable of operating a comfortable headphone or radio pillow. And the headphone people might find a renewed market for modern "cans" if redesigned for the wearer's real comfort—eliminating the old hair-pulling, head-pinching features of the standard article of commerce.

Such a radio could have "high quality" because of the close coupling to the ear; would need very little power output; could be small in size to the extreme.

Tied to the lamp's apron-strings

THROUGHOUT the short life of the electron-tube industry its progress has been hampered as well as aided, by its close affiliation with the incandescent-lamp manufacturing processes out of which it was born. The design of every tube carries unmistakable vestigial evidences of the lamp construction that preceded it. Because the incandescent lamp was already highly developed, and mass production had proceeded far, electronic tubes have been too often "modified lamps," instead of devices specifically designed for their electronic purposes. The bulky size of radio tubes, and the pear-shaped bulbs, bear striking testimony to the tube's lamp ancestry. The pinch-principle of element construction, and the re-entrant stem are both relics, without reason, of incandescent-lamp technique.

Now the tube designers are beginning to cut loose from the apron-strings of the lamp. The new dome-shaped tube, the smaller tube forms, the English "all metal" tube, are evidences of new independence of design.

NEWS NOTES

Is this the record amplification?—In carrying out tests of underground-cable transmission at the Bell Laboratories, New York City, A. B. Clark and B. W. Kendall recently set up the equivalent of a 7,650-mile circuit. To keep speech passing through this required a total amplification of 10^{1200} power, or ten raised to the 1200th power. Such a number, with 1200 ciphers, would alone occupy 20 lines in this column, or twice the length of this item. Bell engineers believe this to be the record amplification to date.

Short-wave radios at London show—Nine miles of exhibit spaces marked the giant radio exhibition held in London during August, with displays insured for $13,000,000. Short-wave sets were featured. Special attention was given to low current consumption with battery sets, made necessary by the multiplicity of lighting voltages in England. These Class B push-pull output circuits attracted wide attention. The Osram G-E Lamp Company displayed its new Catkin all-metal tubes.

Factory payroll increases—Hygrade Sylvania Corporation, with plants at Salem, Mass., Emporium, Pa., St. Mary's, Pa., and Clifton, N. J., increased its employees by 1,400 during August. Accompanying payroll increases were at the rate of $1,000,000 annually, or over 35 per cent. All plants of the company are working at capacity.

Armstrong sustained as inventor of regeneration—The United States Circuit Court of Appeals, Second District, has sustained Major Edwin H. Armstrong as the inventor of the regenerative circuit, in the suit brought by holders of the DeForest patent. The controversy as to who invented the feed-back or regenerative circuit has been in the courts for the past 18 years.

Sir Ambrose Fleming, 83, weds in England—Sir John Ambrose Fleming, who invented the Fleming thermionic rectifier valve in 1904, was married last month to Miss Olive May Franks, 34, an opera singer, according to a London report to the New York Times. Sir Ambrose is now 83 years of age and has been for many years a professor in University College, London.

Motion-picture engineers, Chicago, Oct. 16-18—The Fall meeting of the Society of Motion Picture Engineers will be held at the Edgewater Beach Hotel in Chicago, Oct. 16, 17 and 18. A feature of the meeting will be the announcement and inauguration of the newly elected officers. The semi-annual banquet will be held Tuesday evening, Oct. 17.

COURT RECORD REPORTED ELECTRICALLY

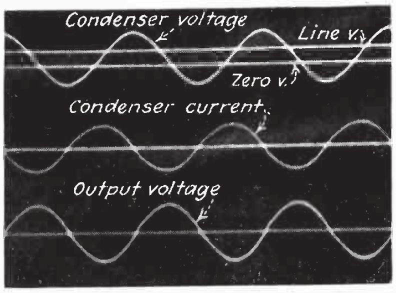
In this court at Hamburg, Germany, electrical recording has taken the place of court stenographers. Attorneys may demand its use at will

ELECTRONIC NOTES

A 75-watt commutator type inverter

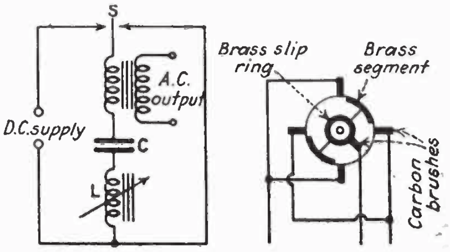
By Herbert J. Reich*

Occasionally the need arises, either in the laboratory or in commercial installations, for a simple device for converting small amounts of d.-c. power into a.-c. of good wave-form without the use of a motor-generator set. Tube inverters are available for this purpose, but the wave-form is usually far from sinusoidal, and the tubes are expensive. The figure shows the circuit of a simple mechanical inverter which will readily furnish an a.-c. output of 75 watts or more at 60 cycles with excellent wave-form and fairly good efficiency when operated on 120 volts d.-c.



Use is made of the fact that in a series circuit containing L, R and C, with a high ratio of L to R, the charging and discharging currents are very nearly sinusoidal. If, therefore, the switch S is changed at the instants when the charging and discharging currents are zero, the condenser will charge practically sinusoidally from the d.-c. supply through the transformer primary and the inductance L, and discharge nearly sinusoidally directly through the transformer and inductance. The transformer primary current and the secondary voltage will be approximate sine waves. Since the current is zero at the instants of commutation little or no sparking occurs. In the practical circuit the double-throw switch is replaced by a commutator driven by a small d.-c. motor.

The correct values of C and L vary with the type of transformer and with large changes of load, but a 250-volt 40 μf. electrolytic condenser and a 50-millihenry low-resistance reactor form a good combination at 60 cycles with the average power transformer. A movable core in the choke makes it possible to tune the circuit to exactly the correct natural frequency, so that no sparking is visible at the commutator. Since the power output which can be obtained at a given frequency is determined by the size of the condenser and the d.-c. voltage, the voltage regulation is poor, and the transformer ratio must be chosen so as to give the necessary terminal voltage at the desired value of load current.



The oscillograms here show condenser voltage, condenser current, and output voltage at 60 cycles with a 50 watt load. The circuit efficiency, neglecting power taken by the motor, was about 60 per cent. The maximum efficiency of about 74 per cent is obtained with an output of 24 watts. Both the maximum power output and the circuit efficiency increase considerably if the series reactor is omitted, but the wave-form becomes exponential, and some sparking is likely to occur at the commutator. The maximum power output is proportional to the condenser capacity and to the square of the d.-c. voltage. High voltage d.-c. may be obtained by rectifying the a.-c. output by means of a second commutator mounted on the same shaft as the first.

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*University of Illinois.

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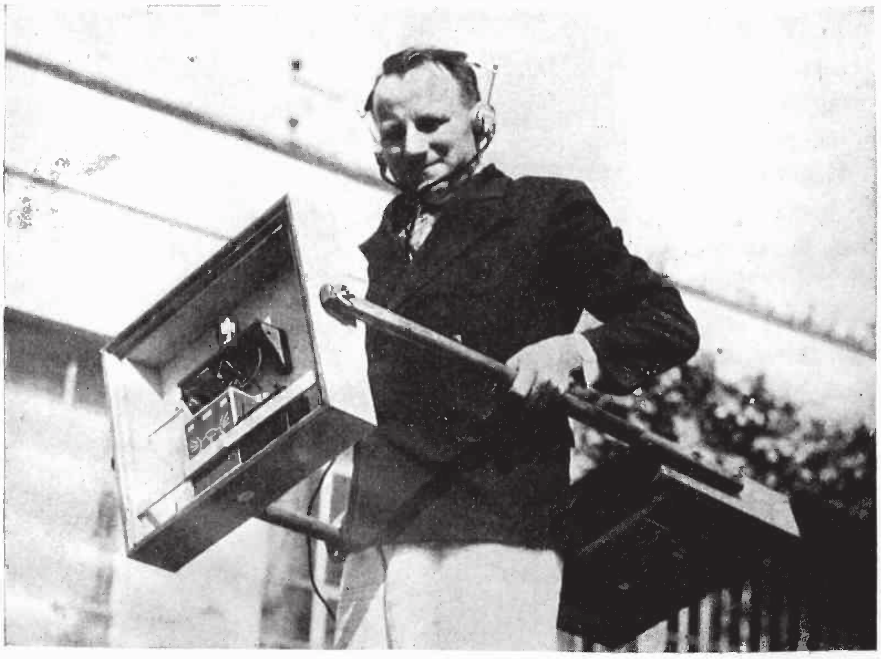
THE METALLASCOPE



Presence of metal bodies within a depth of 10 feet and a radius of 5 feet is made audible by this device perfected by Gerhard Fisher. It weighs 22 lbs.

Low range electrostatic voltmeter

By W. P. Koechel

There are many occasions when it is necessary to have available a voltmeter capable of measuring low values of potential without drawing any current from the circuit being measured. A low range electrostatic voltmeter is an ideal instrument for this purpose but such meters are expensive. By making use of a special vacuum tube circuit it is possible to make up a small and compact vacuum tube voltmeter capable of accurately reading voltages up to 25 volts and having an infinite input resistance. This vacuum tube voltmeter unit can be enclosed in a small portable case and *is in every way comparable to a low range electrostatic meter.* Furthermore it is surprisingly inexpensive and rugged.

Referring to the figure it will be noted that an inverted vacuum tube circuit is utilized. The entire voltage source is obtained from three small flashlight cells. Meter *M* is a 0-200 range micro-ammeter. Tube *T* is a type 30 and therefore the total drain on the flashlight cells does not exceed 61 ma. The voltage drop across resistor R_1 supplies the necessary plate voltage. Resistor R_2 serves as a means for ad-

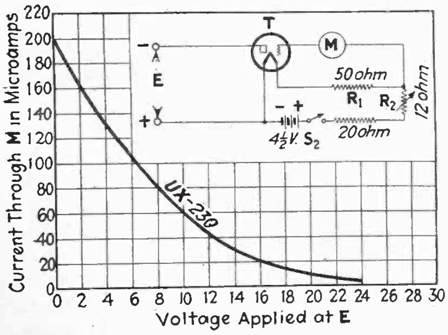
FROM THE LABORATORY ++

justing the circuit to the same plate voltage every time the instrument is used and is really an arbitrary zero setting control.

As the tube is used in an inverted manner, the grid really serves as anode. Being situated so close to the filament it takes only a very small potential to obtain 200 μa anode current. The plate is utilized as a grid and its control over the anode (grid) current is illustrated by the curve. In actual use M is calibrated directly in volts taken from the plotted curve.

The arbitrary zero setting is equivalent to the condition of full scale reading of meter M and this setting is adjusted by means of rheostat R_2. With rheostat R_2 adjusted to give the proper anode voltage, it is obvious that proper filament voltage will also be obtained. *All settings* are therefore taken care of by this one *single control.*

Even though the current drain is very small, it would be detrimental to the battery if left on for any considerable length of time. Therefore switch S_2 instead of being an ordinary toggle switch is combined into a small midget timer (supplied by the Walser Automatic Timer Company). This timer automatically turns off the circuit at the end of each 45 minute period, if the user of this instrument neglects to turn off the switch beforehand.



This meter has an infinite input impedance, but for certain applications it may be desirable to connect a grid leak resistor across the input. Furthermore, the use of a proper grid leak and a condenser in series with the meter permits the measurement of a-c voltage. A number of grid leaks of suitable value will also permit multiplying the scale range of the meter. If these grid leaks are of the order of ten megohms or higher, the input impedance of the meter unit will still be high enough for many applications. In setting for the arbitrary zero value, the input leads should always be shorted.

A few of the uses for which this meter has proven invaluable are:

1. Measuring grid voltages directly at the grid pin of the tubes on life test. (This is not possible with an ordinary meter due to the high protective resistance in series with the bias supply.)
2. Measurement of grid voltage values directly at the socket in radio sets, such as detectors and oscillators where a high resistance is always in series with the grid circuit.
3. Measurement of contact potential and back emission of individual floating elements in experimental tube tests.
4. Measurement of high resistance leakage path.
5. Electrostatic measurements of potentials across charged condensers.

The foregoing are only a few examples of the possible use of such a meter, but every laboratory will find many diversified uses for such an instrument.

◆

Selective fading

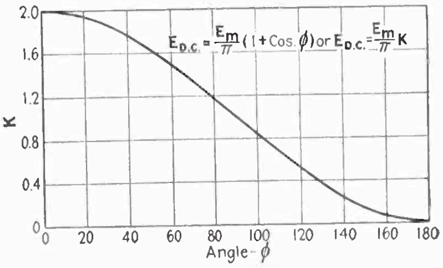
P. H. Handel and H. Plendl of the German Aeronautical Research Laboratory, Berlin, have explored an interesting phenomenon. Certain frequencies out of the 10 kc. band normally transmitted are found to suffer excessive attenuation when the distance between sender and receiver is 10 km. The frequency of a 51.4-m. wave emitted by a horizontal ½-wave aerial oriented north-south was gradually increased until 750 cycles had been added in the course of a ¾ minute, then decreased to normal in another ¾ minute, maintained for about ⅕ sec., and the change repeated. The signals received on an antenna oriented north-south were nearly opposite in phase with respect to signals received on an east-west antenna. This can be accounted for by the rotation of the direction along which the electrical force vibrates, the amount of rotation depending upon the frequency (about ⅜ of a degree per cycle). There are considerable differences in the strength with which four frequencies f (=5.45 mc.) f+600, f+1,850 and f+2,500 are received at different times. The results of the experimental work may be found in *El. Nachr. Technik* 10:76-94. 1933.

◆

Grid-controlled rectifier current

One of the most important functions performed by grid-controlled rectifiers of the thyratron and grid-glow tube types is that of controlled rectification; i.e., current flows through the tube and the load for any desired fraction of the cycle which makes the anode positive with respect to the cathode. Thus the controlled rectifier differs from the two-element or classical rectifier where the current flows during the entire half cycle in which the plate is positive.

The average current flowing in a two-tube full-wave rectifier of this type may be calculated from the following expression taken from *The Electric Journal,* April, 1932, page 192 from an article by Reuben Lee. The curve shows this equation graphically.



$$I_{ave} = I_{crest}\left(\frac{1+\cos\phi}{\pi}\right)$$

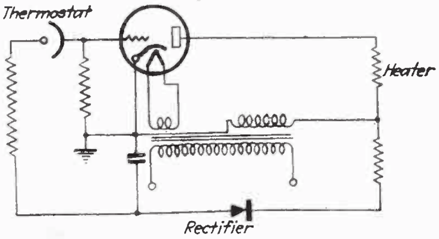
where ϕ=angle at which the tube starts to conduct current.

Curve furnished by Dr. Dayton Ulrey, Westinghouse Research Laboratories. The angle ϕ is the point in the cycle at which current flow starts.

◆

Tube control of temperature in crystal ovens

In the crystal oven ("incubator" to the British) used to maintain the frequency of G5SW at 11,750 kc. the constant temperature is maintained by a thermostat which through a grid-controlled rectifier of conventional type (1,000 volt, 0.25 ampere) switched on and off the a.c. to the heating coils. By use of a copper oxide rectifier the necessity of using a grid bias battery was obviated.



Ordinarily a fixed bias supplied by the battery maintained the grid at such a potential as to control the plate current. This battery required space, and of course had to be replaced. The circuit shown in the figure indicates how the rectifier replaced the battery. The grid bias was about 50 volts after supplying 210 volts a.c. through 50,000 ohms and 0.5 μf.

The frequency of this station, which was used for the early experiments on Empire broadcasting, was kept within 4 parts in a million of its assigned frequency for long periods of time.

HIGH LIGHTS ON ELECTRONIC

Smoke precipitation with electronic rectifiers

For years men have been taking valuable products out of smoke and gas by electrically precipitating the materials they contain. The gases from smaller smoke stacks, the flues of cement kilns, natural gas and water gas with their fine mist of tar; from all these can be taken, if not gold dust, its equivalent. Sometimes it is not the dust that is valuable, but a gas which must be cleaned to be used, like furnace gas in a steel mill.

Electrical precipitation requires direct current of very high voltage. Hitherto it has been produced by mechanical rectifiers. Such rectifiers, troublesome to their operators and a source of radio interference, are no longer necessary. Their duty can be performed by two-element high-voltage vacuum-tube rectifiers which are quiet and positive, of fixed and unvarying polarity, with smooth and regular wave form. They do not burn themselves up with arcing, and radio sets find them silent. The tubes are shielded by glass cylinders from emitting possibly dangerous X-rays.

One set, built by Westinghouse engineers, delivers from a 25-cycle supply an average rectified current of 400 milliamperes, at a maximum pressure (r.m.s. value on transformer) of 100,000 volts a figure which can be reduced by an induction regulator to 47,000 volts. The filament transformers are inside the main tank. Filament voltage is kept practically constant, even if the line voltage varies 10 per cent, by a static regulating device.

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Microphones and loudspeakers in butcher shop

A butcher's shop, clean and germ-free like a hospital operating room, has been opened in Paris with the public blessings of several professors of the faculty of medicine and of representatives of the local authorities.

Dr. Kaplan, the author of this new venture in practical hygiene, has installed his salesmen in a huge glass chamber, the air of which is constantly being renewed and filtered, and kept at a temperature of 45 degrees Fahr. The salesmen wear rubber gloves and are dressed in white from top to toe. They cut up, weigh and pack the meat under the eyes of their customers with whom they communicate by means of microphones and loud speakers.

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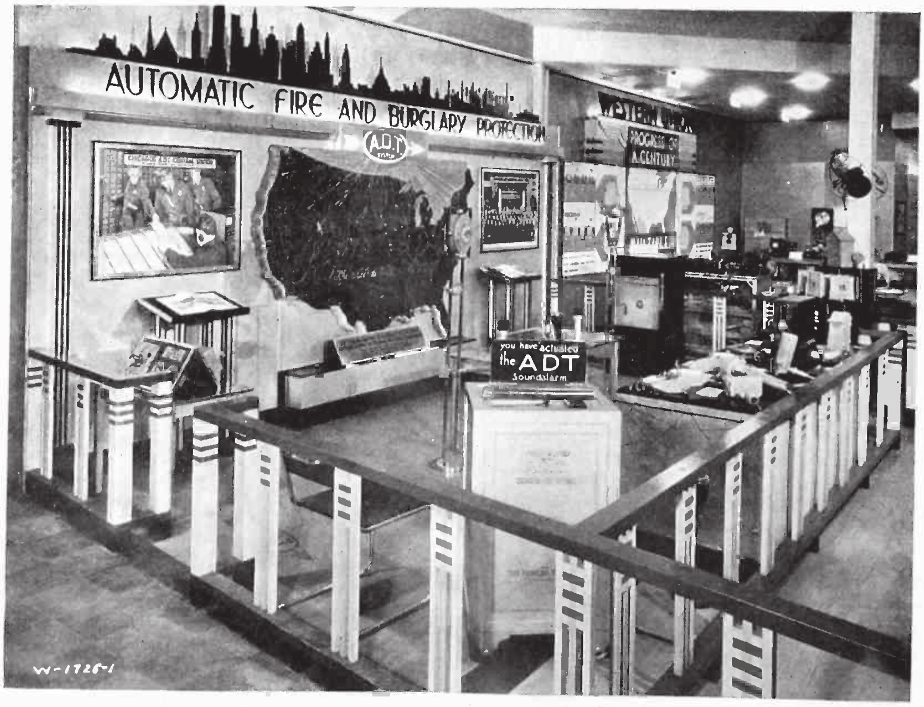
APPROACH SAFE, ALARM RINGS


AUTOMATIC FIRE AND BURGLARY PROTECTION
A.D.T.
WESTERN UNION
PROGRESS OF A CENTURY
you have actuated the ADT Soundalarm
W-1726-1

At Chicago, World's Fair crowds marvel at this A.D.T. Company exhibit of a safe with "space alarm." On merely approaching the safe, one's body sets a big bell ringing

Booth demonstrator reduces annoyance of booming low tones

How a demonstrator's words may be understood by his audience without at the same time disturbing people outside the circle of listeners is interestingly shown in the Bell System exhibit at the Chicago Exposition.

Loud-speaking systems for such demonstrations have frequently been tried, but often with so much annoyance to unwilling listeners that they soon had to be discontinued. A principal cause of this is the carrying power of the low-pitched tones which emanate in large volume from most loud-speaking systems.

In designing the Chicago Fair installation, however, apparatus was produced which would favor the higher pitches, important to intelligibility, while discriminating against the merely noisy components which would boom out for hundreds of feet. At Chicago, this equipment is built into the demonstration booths, but it is commercially available in portable form as a single case which can be carried by one man and set up for use in a few minutes.

✦

Burglar alarm employs space principle

The Holmes Electric Protection Company of New York, which provides electrical alarms and supervision for business houses and banks, is now carrying on experiments with a space alarm, by which the mere approach of a marauder into the vicinity of a door, wall, table or safe can be detected.

As developed in the company's laboratory under the direction of L. H. Chase, electrical engineer, the outfit is compactly contained in a small carrying case which can be operated on either batteries or 110-volts alternating current. The output on a frequency between 4,000 and 5,000 kilocycles is accurately maintained by means of a crystal. The space alarm transmitter can be connected to any object or circuit it is desired to protect. In the case of a wall or doorway or furniture, adhesive metal foil is stuck onto the surface.

The new principle seems especially adaptable to the safeguarding of safes and strongboxes. Such a safe can be so arranged that anyone approaching it sets off the alarm, and under no conditions can the sensitivity of the system fall so low, even with the changes in conductivity due to damp weather, that the alarm is not sounded upon the slightest touch of the safe.

DEVICES IN INDUSTRY + +

Fewer failures under photocell-controlled school lighting

A 20 PER CENT REDUCTION in school failures has been the result of the two-year test in class room lighting conducted by the Tuscumbia (Ala.) City Schools in cooperation with Alabama Power and General Electric engineers.

Faced with the statements of educators that from 8 to 15 per cent of school children acquire defective vision within the few years of their school lives, F. C. Albert, a lighting engineer of the power company, sought the aid of the city schools in an experiment to prove his theory that poor lighting in the average school is robbing many of the nation's children of good vision.

Two school rooms were selected containing the same floor space and window area and with the same exposure to the sun. Each was already equipped with two 150-watt direct lighting fixtures controlled by a wall switch. In one this lighting equipment was permitted to remain unchanged, and in the other it was replaced with four Curtis 300 watt indirect fixtures controlled by a photoelectric relay, arranged to maintain a light intensity of 12 foot candles.

After standard "achievement" and Otis "intelligence tests," an equal number of pupils of the same rating were assigned to each room, and great pains were taken to balance the two groups as equally as possible in talents, intelligence and past achievements.

At the end of the first school year, it was found that it had been necessary for the lights controlled by the "electric eye" to operate 34.1 per cent. of the school hours to maintain 12 foot candles of light during school hours on the last three rows of desks farthest from the windows. At the end of the second year the lights had operated 32.6 per cent of the school hours to maintain the same intensity of light.

The first year's test developed 4 failures out of 36 pupils in the light-controlled room, as against 11 failures out of 34 pupils in the other room, an actual decrease of 20 per cent. The standing of the children in the photocell room was so astonishing as to grades, attentiveness and alertness that the experiment was continued a second year to check the methods of dividing the classes as well as the results. The second year's results duplicated those of the first, there being 8 less pupil failures in the photocell room than in the other, out of 42 pupils in each room.

Of equal importance, the teachers testified "The children in the photocell room were much more alert, cheerful and attentive, while those in the other room seemed restless and sleepy on dark days and were harder to teach."

The electric energy consumed in each room was metered and the cost of the additional electricity for the high-intensity lighting was $22.35 for the term. The annual cost of educating each pupil for the 1931-32 term was $28.

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Photocell smoke detector as "combustion-indicator"

C. C. SHEPPARD of the Ess Instrument Company, 30 Church St., New York City, has found it possible to employ some of his photocell smoke-detecting units as "combustion indicators," showing by means of a meter dial the exact condition at which combustion is proceeding most efficiently, such as the "haze-point" with oil-burning furnaces. With a meter calibrated at 100 for smoke, a reading of about 20 indicates a slight haze. Contacts introduced bracketing the needle above and below 20, can be arranged to light red and green lamps respectively, showing when the flue gases have too much air or too much unburned fuel.

Mr. Sheppard has installed a number of straight photocell smoke detectors in the New York area, in such prominent buildings as those of the Metropolitan Life Insurance Company, Standard Oil Company, Home for the Aged, New York Central power house, Port Morris, and Prudential Life Insurance Company, Newark, N. J. Photocell smoke detectors on ships offer another possibility, replacing the visual type of inspection tubes now installed at great expense.

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Sounds that cause chemical changes, cooking

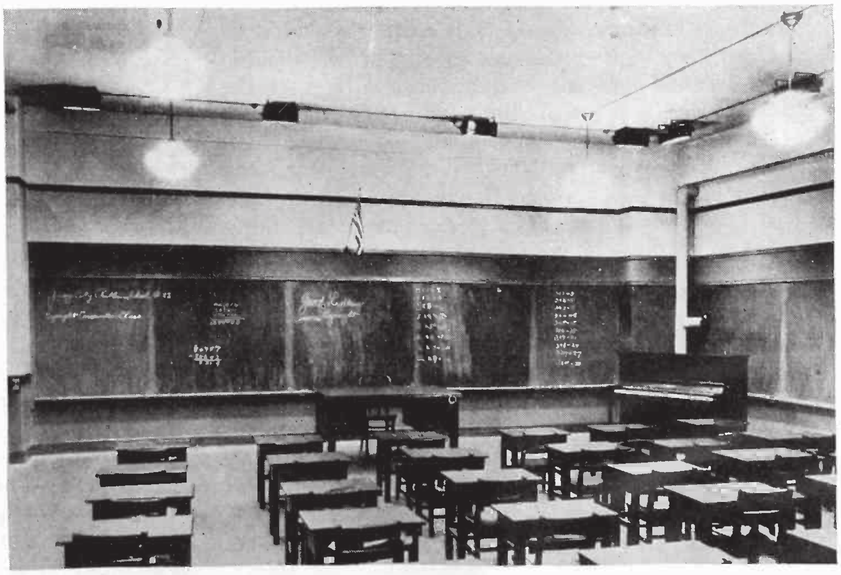
SOUNDS CAN CAUSE chemical changes of various kinds, if the sounds are only intense enough, according to a report presented to the Chicago meeting of the American Association for the Advancement of Science, by Dr. E. W. Flosdorf and Dr. L. A. Chambers of the University of Pennsylvania School of Medicine.

The sounds, projected into liquids, coagulated proteins, broke down ethyl acetate to produce acetic acid, "cracked" vegetable oils with the production of acetylene gas, and to a small extent decomposed starch to produce glucose.

A spectacular demonstration was the apparent soft-boiling of an egg subjected to the intense sound for a few minutes without any raising of the temperature.

The experimenters believe that these chemical actions are due to a momentary kinetic, or speeding-up, effect on the molecules involved, affecting them in much the same way as heating.

Most of the sounds used were very shrill, but one experiment employed tones only two octaves above middle C on the piano.



After two years' test of photo-cell controlled lighting in the Tuscumbia (Ala.) schools, brighter scholars, better grades, and fewer failures are reported

Loudspeaker cost vs. quality

[*Continued from page 242*]

cut off raises the permissible distortion. A 3,000 cycle peak produces what the average listener calls "highs."

For any given voice coil and cone there is a level at which the speaker gives maximum loudness efficiency. This is the point at which the cone just begins to break up. In small speakers the diaphragm is made so light that this critical level is reached with maximum input from the set. Therefore, when its loudness efficiency is compared with a large speaker which is intended to handle perhaps 6 or 8 times the power and, therefore, is a long way from its break up point the relative loudness efficiency of the latter suffers by comparison.

Cost versus quality

All of the factors discussed vary considerably in different speakers and it is, therefore, difficult to give concrete data which will help the set designer. To give some idea, however, of at least the general relationship between loudness efficiency and cost Figure 8 has been prepared. These data were obtained by measuring a number of speakers in each price range and taking the unweighted average of the loudness efficiency with music and voice input. Curve A shows roughly the way in which loudness efficiency varies with cost. As would be expected, for very high efficiencies a point of diminishing returns is reached and the cost rises rapidly. At the low efficiency end a point of diminishing returns is also reached since the labor involved in making a very small speaker differs comparatively little from that of making a somewhat larger speaker and the reduction in the material cost is not enough to offset this. The curve, therefore, starts to flatten slightly.

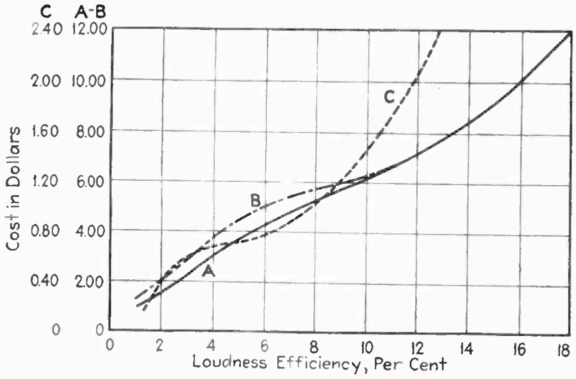


Fig. 8—Cost versus loudness efficiency showing operation of law of diminishing return

Cost per decibel gain

If the small speaker is required to have as little steady state and transient distortion as the larger speaker, then the cost must be increased to maintain the same loudness efficiency. The estimated cost of producing small speakers with the same distortion now permitted in large speakers and with the same design factors (temperature, rise, etc.) is shown in curve B. It will be noted that in terms of percentage increase, there is considerable increase in cost in the cheapest speakers.

Curve C shows the cost of getting an additional db (approximately 26 per cent increase in efficiency at any point. For example, if the loudness efficiency is 4 per cent, the cost of obtaining an additional db of loudness efficiency is, roughly, 68 cents.

In the design of a receiver, there are usually one or more points at which the cost of obtaining additional audio output increases sharply. This occurs, for example, when it is necessary to go from a single tube to two tubes in push pull when a transformer is added.

Because of the large variation in the cost of getting additional audio power in the case of different receivers made to sell at different prices, a curve corresponding to curve C, Fig. 8 for receivers must necessarily be made by each individual manufacturer with a particular series of designs in mind. Such a curve can then be used to determine the cost of various amounts of sound output. In the case considered above, for example, one db increase in the electrical output of the set might mean increasing the output from 1½ to approximately 1.9 watts. This might involve going from a single 43 to a pair of them in push pull if the plate voltage were limited. If the change would involve more than 68 cents, it would be more economical to increase the loudness efficiency of the speaker.

In general, this procedure cannot be justified if nothing but the loudness efficiency is considered. The power handling capacity of small speakers is, however, limited so that even if moderate distortion can be tolerated, it it frequently necessary to increase the size of the speaker to increase the total sound output that can be gotten even though additional audio power is available.

In more expensive receivers, fidelity is of greater importance and here the more efficient speaker justifies its additional cost by the lowered steady state and transient distortion as well as by the improvement in efficiency. The high efficiency speaker would be very common if the same distortion requirements were placed on the small speaker that obtain on the larger ones.

In spite of the high cost per db in large speakers, it is important to remember that the cost per db of set output also rises rapidly beyond a certain point because of the larger tubes involved and the higher voltages necessary. For this reason even in public address work where moderate distortion is usually tolerated, it frequently pays to use a more efficient speaker because the audio frequency output cost rises rapidly in an amplifier designed to supply more than about 20 watts.

The small speaker—pro and con

Summarizing, we see that as the efficiency of the loudspeaker is decreased in the piston range the loudness efficiency decreases more slowly. Small speakers, therefore, have relatively better loudness efficiency considering the amount of material used in their construction for all or most of the following reasons:

1. Greater output at resonance as critical coupling is approached between electrical and mechanical circuits.
2. Greater high frequency output because of the reduced voice coil mass.
3. Increased steady state distortion which also increases the apparent bass.
4. Operation nearer the critical cone "break up" point.
5. Common use of 400 circular mills per ampere in the field with very high field temperatures.
6. Use of "commercial" gap clearances which give greater voice coil alinement problems than would obtain in a conservative design.

The advantages of the small speaker are:

[*Please turn to page 260*]

Initial impulse indicator

By O. W. LIVINGSTON
and H. W. LORD
*General Electric Company,
Schenectady, N. Y.*

THIS article deals with a general method of determining which one of a series of rapidly occurring events happened first, together with a practical application of the principle.

It is first necessary to reduce the events which we wish to observe to voltage signals. In electrical circuit problems these voltages are often present or obtainable with little trouble but in other cases it may be necessary to translate sound, motion, or light to an electrical signal by the use of microphone, contact or phototube.

Figure 1 shows a circuit which may be used to determine which of three impulses occurs first. Let the source of the three impulses be connected between X_1-C, X_2-C, and X_3-C respectively and the switch S_1 closed. The voltage drop across the resistor R_1 is the anode potential applied to the three grid controlled rectifiers T_1, T_2, and T_3 and the voltage drop across R_2 supplies a bias normally sufficient to keep the tubes nonconducting. Let us assume now that an impulse is received at X_1-C which momentarily throws the grid of T_1 positive. The tube starts conducting within a few microseconds reducing the anode to cathode voltage to about 15 volts. This decreases the voltage across the resistor R_1 to this same value and the balance of the d-c voltage must appear across R_2. Thus, once tube T_1 starts to conduct the anode potential on all the other tubes is reduced and simultaneously their grid bias is increased making it impossible for them to conduct even if they receive subsequent impulses. Thus, the first tube to receive an impulse remains conducting until it is observed and the circuit reset by momentarily opening S_1. Of course this circuit may be extended to include any number of impulse sourses by adding an additional tube for each impulse source.

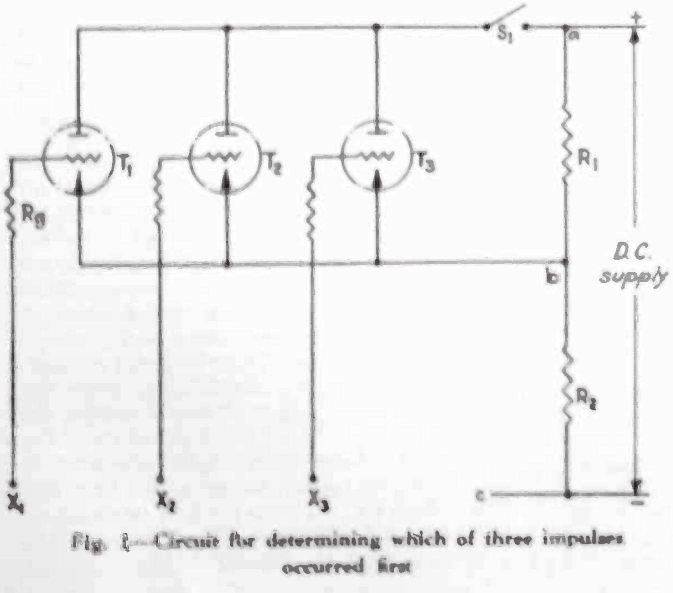


Fig. 1—Circuit for determining which of three impulses occurred first

Applications of the impulse indicator

One of the most useful of the applications of this circuit has been for arc-back indication in mercury vapor rectifier sets. If tube trouble is experienced in a multi-tube rectifier set it is often difficult, particularly with the modern trend toward metal tubes, to determine which tube is at fault. In the past simple magnetic reverse current relays have been used in the individual anode circuits but this is not very satisfactory since an arc-back in one tube generally produces a severe overloading of the other tubes, often causing them to arc back through no fault of their own. It is not uncommon to find all of these indicators open after a severe arc-back which, of course, does not help much in locating the trouble.

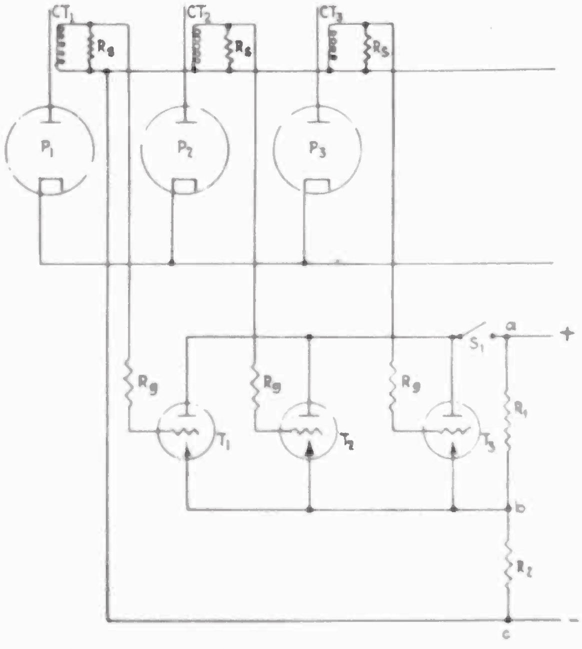


Fig. 2—Connections of impulse indicator to a three-phase rectifier

Figure 2 shows how the initial impulse indicator may be connected to indicate which tube in a three phase outfit is causing the initial trouble. Current transformers shunted by resistors are inserted in the anode leads of the power tubes as shown, so that as long as the current flows in the proper direction the current transformers are practically saturated and any small output voltage left tends to make the grids even more negative. As soon as a tube arcs back, however, a current of 10 or 20 times normal, depending upon the power transformer impedance, flows through the current transformer of the arcing back tube causing a positive signal on the grid of the associated tube. This tube then remains "on" re-

[*Please turn to page 260*]

REVIEW OF ELECTRONIC LITERATURE

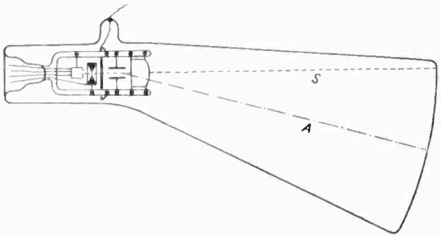
HERE AND ABROAD

Secondary electrons in screen-grid tubes

[J. HERWEG and G. ULBRICHT, Hannover Inst. of Technology.] While screen-grid tubes have to be operated with the plate at a much higher potential than the screen in order to get rid of the effect of secondary electrons, other portions of the characteristics may one day become useful. When in a screen-grid tube (H 4100 D), the screen is left at 100 volts, the control grid is made positive and the plate potential is increased from zero upward, the curve showing the plate current at a given grid voltage rises first, then drops with a slope which is steeper the more positive the grid, and starts to rise again at a potential which is higher the lower the grid voltage, but in any case only slightly above the point where the plate potential becomes higher than the screen voltage. The curves resemble in shape those obtained under normal operating conditions. The control grid exerts a strong influence upon the current, its value being 4, 12, and 21 ma. for zero, 4 and 8 volts on the grid (mutual conductance 0.005). Tubes with coaxial cylindrical electrodes do not show straight slopes, and some portions of the curves may vary from day to day. As the mutual conductance is given by the horizontal distance between the curves, it is very variable, starting with very high values at zero plate voltage, becoming negative in the falling portions and rising to a few hundred per cent.—*Hochfr. Techn. u. El. Ak.* 41: 189-194, 1933.

Distortion produced by space charges in cathode ray tubes

[E. HUDEC, German Central Post Office Laboratory.] The distortion occurs in tubes with incandescent cathodes when the plate potential is 2,000 volts and the normal discharge current of a few tenths ma. is exceeded so as to obtain greater intensity for the brighter portions. The image appears distorted in the neighborhood of the horizontal, or vertical middle-line of the screen, or both, that is when the deflecting potential passes through zero. The effect is due to space charges formed by the positive ions in the neighborhood of the deflecting plates, and the electric forces they exert. It can be eliminated at the expense of brightness by reducing the pressure of the gas remaining in the tube. It is better and simpler to make the former center of the screen the edge of the screen, extending the screen to one side in order to give it its former size. The electron beam must be moved closer to one of the deflecting plates. These off-center screens, and tubes making an elbow between the screen and the deflecting electrodes give perfect reproduction.—*El. Nachr. T.* 10: 215-220, 1933.



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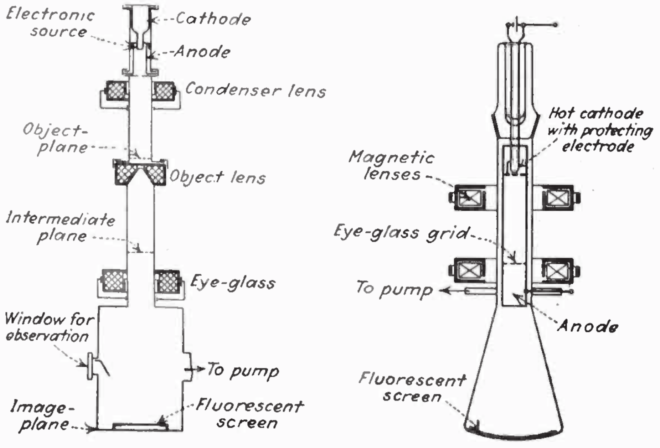
ELECTRONIC MICROSCOPE



Left, cold cathode; right, hot cathode microscopes of Knoll—see page 243 this issue of Electronics

Temperature of oxide coated filaments

[P. CLAUSING AND J. B. LUDWIG. Philips Research Laboratory.] Data on the electron emission of oxide-coated filaments as a function of their temperature vary a great deal owing to the difficulty of determining the temperature from the light radiated. An oxide-coated platinum filament gives a total radiation of about 8 watts per sq.cm. at 1,200 deg. abs. with a konel core 5 and with a nickel support 2 watts. The reason for the difference is that light from the core passes through the thin oxide layer, so that the radiation from strontium oxide on a nickel support increases first with the thickness of the layer (from 0 to 33 microns) and decreases beyond this value to become constant at about 0.1 mm.—*Physica 13;* 193-205, 1933.

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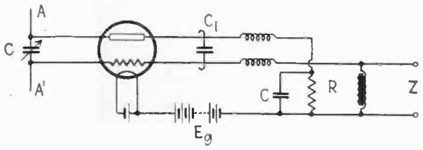
Secondary electrons in screen-grid tubes

[C. J. LUSSANET DE LA SABLONIERE, Philips' Research Laboratory, Eindhoven.] Knowledge of the part which secondary electrons play in screen grid tubes is useful because they limit the range over which the tube can be used. When the ratio a of the plate current I_p to the total current $I_s + I_p$ as depending upon the ratio V_p/V_s is plotted for a series of negative grid voltages, but constant ratios screen to grid voltage V_s/V_g, a family of similar curves is obtained which rise, fall and rise again to pass all through nearly the same point when V_p equals V_s. A simple curve following the first ascending portion of the curves and passing then through the common point $V_p/V_s = 1$ represents the ratio b of the number of primary electrons hitting the plate to the sum of screen and plate current $I_s + I_p$. It can be shown that any one of the b curves can be deduced from the a curves when only one point of it has been found by direct measurement or more simply by drawing a series of curves for various assumed b values, first in the range where V_s is larger than V_p and then in the region where V_s is smaller than V_p, and choosing as the correct b curve those two positions which most closely prolong one another. From these two families of curves the ratio of secondary electrons leaving the plate to primary electrons hitting the plate is found by a simple calculation, at any one point as equal to $(a - b)/(1 - b)$. Various types of tubes examined did not show saturation.—*Hochfr. u. El. Ak.* 41: 195-207, 1933.

Positive-grid amplifying detector for 10 cm. waves

[H. E. Hollmann, Heinr. Hertz Institute, Berlin.] The new circuit is based upon the fact that when tubes with cylindrical electrodes and positive grid are worked near saturation and the electrodes are far apart (small mutual conductance) the grid current decreases from its saturation value at negative plate potential to a constant value as the plate becomes more and more positive, and the plate current increases from zero to a constant value. The sum of both currents is equal to the total emission. In the transition region, where the plate current starts to grow and just before it becomes constant, rectification is produced as the result of the non-linear characteristic, the characteristic being nearly independent of the grid potential when the mutual conductance is small. The modulated incoming wave is applied between plate and grid, the output transformer is placed in the grid circuit.—*Funkt. Monatsh.* 2: 249-253. 1933.



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The effect of metallic shields on tuning coils

[H. Kaden, Siemens and Halske Research Laboratory, Berlin.] To facilitate the correct design of shields for r-f coils the author develops practical formulas showing how much the inductance L_0 drops and the resistance increases when a tuning coil is placed in the center of a metal box and what is the ratio S of the field outside the screen to the field without shielding. For ordinary non-magnetic materials, such as aluminum or manganin of specific resistance r, radius R and with walls d cm. thick the formula holds that $1/S^2 = (\cosh 2p - \cos 2p)\, p^2R^2/9d^2$ where $p = 0.02\, d\sqrt{f/r}$. The resistance of the coil increases as the reciprocal of the fourth power of the radius R, the value $1 - L/L_0$ decreases with the reciprocal of the third power. For a shield of manganin of 4 cm. radius (r about 40 ohms per sq.cm. and cm. or $p = 0.6$ when $d = 0.5$ mm.) the ratio S comes out to be 1/20 at 150,000 cycles, the inductance L_0 is reduced to 0.88 of its initial value L_0, and the phase angle caused by the shield is 0.007. For an aluminum shield ($R = 2.54$ cm. thickness $= R/100$), the outside field is reduced to about 1/100 at 100,000 cycles and to 5/10,000 at 1,000 kc. The formula for the outside field agrees with the theory given by Prof. L. V. King in *Phil. Mag.* 15: 201-223. 1933.—*El. Nachr. Techn.* 10: 277-285. 1933.

Shielded antenna leads

[E. Schwandt. O. Nairz.] Two types of shielded connections between antenna and receiver have been developed, one a shielded light cable which can be freely suspended from the antenna when the length does not exceed 100 feet. When longer leads are required it is necessary to use lead-clad cables mounted on the wall. Parts fitting any size of cable, parts for bridging gutters and special end pieces are available. It is important that shielding be continuous and extends to the lightning arrester, which enters into action at 350 volts, and the earthing switch prescribed by regulations.

The second author describes how he secured satisfactory reception with the aid of a shielded lead-in in a house on a street car line where it was at times impossible to receive a local station 15 miles away.—*Funkt. Monatsh.* 2: 255-257. 184-185. 1933.

◆

Filter-type interstage amplifier coupling

Through error the circuit of Mr. Stone's interstage coupling device described on page 194, July *Electronics,* was not given correctly. As described, this interstage coupling system involves a mid-series termination low-pass filter. Of course the two end inductances in such a filter have one-half the inductance of the central inductance. Therefore the three inductances from the plate down should be $L/2$, L and $L/2$.

◆

The radiometer as field strength meter

[G. Beauvais, French National Radio Laboratory.] To measure the field strength produced by tubes giving 10 to 20 cm. waves the author uses the rotation of a half wavelength radiometer vane placed in a small glass container in which the pressure has been reduced to 1/100 mm. mercury. A thin narrow foil of aluminum forms one long side of a small rectangular frame, a mica sheet of the same dimensions the other long side; a fine wire running midway between these two sides carries a light mirror, and suspension wires are attached to the cross-pieces between the wire and the aluminum foil. The frame is then bent around the central wire as an axis so as to place mica and aluminum face to face. At the resonance point the current induced by the field in the aluminum foil heats the foil and the impact of the gas molecules causes the whole frame to turn. The direction and strength of the field can thus be explored without the use of meters and connecting wires. The field strengths studied are of the order of 1/100 volt per m.—*Onde électrique* 12: 213-235. 1933.

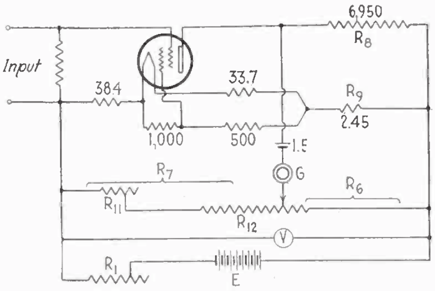
Further work on ultra-short wave tubes (12-15 cm. waves)

[E. Gossel, University of Erlangen.] Earlier results, namely, that the coaxial cylindrical positive grid and negative plate with their lead-in wires may vibrate together, or that the grid spiral may vibrate as one whole wavelength, were confirmed. When the length of the circuit connected to the grid is changed, a series of values are found at which the tube generates maximum energy at the same wavelength. When instead of leading the wires coming from the ends of the grid spiral in a straight bend to the base of the tube, the grid is shorted by a second spiral of the same dimensions, the grid potential being applied at its center, the tube is capable of giving strong vibrations of wavelength 22.5 cm. and 14 cm. In this case the electrical oscillations take place in the planes parallel to the turns of the spiral, not parallel to the axis as is the case with a single spiral and a straight bend. It is also observed that on changing the tuning of the plate grid circuit values are found at which this circuit withdraws energy from the oscillating grid system so that the energy radiated by the grid passes through low values. The heating circuit may also be set into resonance for certain values of the electron emission.—*Hochfr. Techn. & El. Ak.* 42: 1-10. 1933.

◆

An improved balanced circuit for electrometer tubes

The FP-54 tube can draw both its filament and plate currents from one battery, but for stable operation the resistances have to be appropriately chosen. The characteristic of the tube is first obtained under approximately the conditions under which it will be used in the balanced bridge. In arranging the bridge the tube can be thought of as a combination of a resistance R and an effective emf. E. Zero current will be obtained in the bridge provided that $R_8/R_T = E_B/(E - E_B)$, and $R_7/R_6 = R/R_8$ and a suitable value of R_8 can be calculated. Varying R, makes the reading of the bridge galvanometer pass through a minimum which can be reduced to zero by adjusting R_{11}. — *Rev. Scient. Instr.* 4: 429-433. 1933.



Initial impulse indicator

[Continued from page 257]

gardless of any subsequent events until S_1 is opened, clearly indicating where the trouble originated.

Figure 3 shows an oscillogram of an arc-back on a three phase half-wave outfit. The oscillograph elements were inserted in the anode leads of the tubes so that the normal direction of current flow gave a deflection above the zero axis. Several cycles after load was applied an arc-back occurred in tube No. 2. This caused an overload on tube No. 3 causing it to arc back in the next half cycle. Before the breakers opened, an arc-back occurred in the tube No. 1 as the result of a second failure of tube No. 2. Under these conditions if simple reverse current relays had been inserted in the anode leads, all three would have indicated a fault which would not have helped to locate the faulty tube. Using the initial impulse indicator, however, the tube in the second position was turned on, clearly indicating where the trouble was.

A six tube initial arc back indicator has been built in portable form. Six "clamp on" current transformers are carried in the bottom section of this portable device which make it possible to investigate trouble in any outfit having six or less tubes.

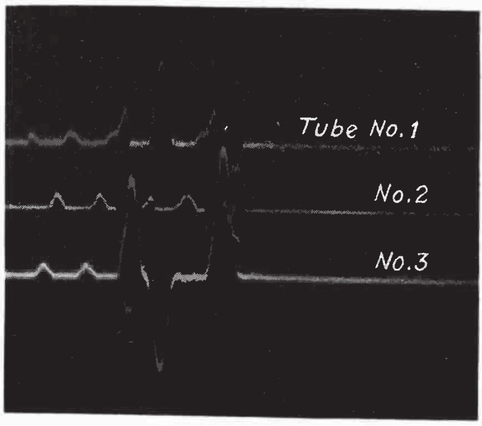


Fig. 3—Oscillogram of arc-back on three-phase half-wave rectifier

Other applications of this indicator will doubtlessly be found both in the field of industry and in the field of amusements.

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Loudspeaker cost vs. quality

[Continued from page 256]

1. Better extreme high frequency response can be obtained with small inputs due to the reduced voice coil mass.
2. Slightly improved polar characteristic.

The advantage of (1) is lost because the speakers are operated near their critical level and are required to show little distress with a distorted set output.

The advantages of the large speaker are:

1. Higher energy and loudness efficiency.
2. Absence or minimization of transient distortion at fundamental resonance. This permits high fidelity when it is wanted since it permits the set designer to introduce the low frequency resonance electrically so that it is under control in either a continuously variable or semi-permanent adjustment.
3. Low steady state distortion. Since existing distortion contributes very little to the loudness efficiency it could be considerably reduced at but slight loss in loudness efficiency.
4. Operation far below critical level permits the effective frequency range to be extended further than it is in small speakers.
5. Moderate excursion results in only slight changes in the physical constants of the mechanical system with life (in 5-inch speakers, the stiffness of the annulus sometimes changes so rapidly that distortion measurements at resonance with full input cannot be made before the resonant frequency drops).
6. More conservative voice coil clearance with improved alinement life expectancy.
7. Conservative temperature rise with further improved life expectancy.

The use of the 5-inch speaker has been made possible because of the very surprising amount of distortion the public will tolerate[3]. In some unpublished tests of permissible distortion in music with 3,000 cycles cutoff, we have found that with an inexperienced listener, 40 per cent second harmonic distortion can be tolerated in the absence of a distortionless source with which to compare it.

Another factor has been the public acceptance of very small sets which necessitated small speakers if the set was to be completely self-contained. The present move toward the use of a separate speaker with good fidelity should provide the portability and appeal of the small set with the fidelity and advantages of the large speaker and baffle.

In addition to the separate speaker trend, there appears to be a general increase in interest in high fidelity receivers. Any general improvement in this direction will probably have to result from a change in the public's interest in sets which sound like a radio to sets actually built to reproduce the original with good fidelity. There will undoubtedly be a transition period during which many sets will be arranged so that high fidelity reproduction will be possible and so that the "boom," middle high frequency peak and the high frequency cutoff can be taken care of by distortion controls.

The psychological fact that one is listening to an artificial source of music seems to have a bearing on this point. Even those whose ears have been trained to musical appreciation seem to be easily misled by this factor. The number of times is legion that a trained musician has termed as "perfect" a specimen of radio reproduction which was really limited in tonal range, severely compressed in volume and full of distortion.

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[1] The relative loudness efficiency of two speakers may be defined as the reciprocal of the power input for a specified impedance to give the same loudness. See I.R.E. 1933. Report of the Standards Committee, page 164.

[2] See Rayleigh Theory of Sound, Vol. 2, page 165. Cone excursion given in May, 1932, *Electronics*, page 154 were too high because of exponent of π.

[3] The permissible distortion in speech Frank Massa, May, 1933, I.R.E. Proceedings.

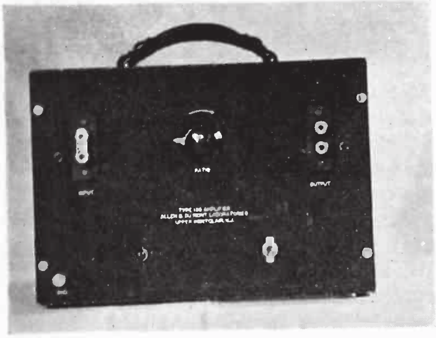
This paper by Mr. Knowles was delivered in abbreviated form at the recent annual convention of the Institute of Radio Engineers.

+ NEW PRODUCTS

THE MANUFACTURERS OFFER

Amplifier for oscillograph

To EXTEND THE RANGE of the cathode-ray oscillograph a special high quality a-c operated amplifier has been developed by the Allen B. Du Mont Laboratories, 9 Bradford Way, Upper Montclair, N. J. This amplifier may be used for the measurement or observation of many effects which of themselves are not of sufficient magnitude to operate the cathode-ray tube directly but which nevertheless should not be entrusted to an ordinary amplifier for their faithful reproduction. It may also be used for many laboratory problems not connected with the cathode-ray oscillograph.



This Du Mont Type 136 amplifier is a three stage unit with power supply which has a voltage amplification of 500 and will deliver 50 volts r.m.s. to the cathode-ray tube. The input impedance is one megohm and the output impedance is 7000 ohms resistive. The ratio of output to input voltages does not vary more than 3 per cent from the 1000 cycle value between 10 and 100,000 cycles in which range the phase shift is proportional to frequency, there being a lag of 8 degrees at the upper frequency. The ratio of output to input voltages does not vary by more than 5 db. from the 1000 cycle value between 100 kc. and 900 kc.

The amplifier is priced at $120, complete with tubes.—*Electronics.*

Transformers and chokes

CENTRAL RADIO CORPORATION, Beloit, Wisconsin, has added a transformer and choke division to its socket line. This new division will specialize in small transformers, audio frequency and filter chokes, featuring new designs in this field. Exhaustive field and laboratory tests over a period of two years have proved the soundness of the new designs. Standard mounting centers have, of course, been adhered to. Some of the features of the new device are greater inductance, smaller sizes, lower cost and greater breakdown voltages, as well as a new and convenient lug terminal. J. C. Snell will head this new division.—*Electronics.*

Photronic Kit

THE WESTON ELECTRICAL INSTRUMENT CORPORATION, 614 Frelinghuysen Ave., Newark, N. J., has just announced a new, inexpensive Photronic control kit which is being marketed especially for those engineers and manufacturers who prefer to do their own experimenting with photo-electric control for mechanical equipment, operations and for processes of various kinds.

The kit contains all the equipment necessary for the engineer to start immediate experiments. The equipment can be used as a smoke detector, burglar alarm, turbidity detector, door opener, counter for all classes of service, safety device on machines, etc.

The cell included in the kit is the Weston Photronic cell which has the peculiar faculty of transforming light energy directly into electrical energy, and operates the Weston relays without the use of any auxiliary apparatus or batteries. As far as is known, the cell has unlimited life and the output is constant. Its spectral response is about the same as the human eye, so that it is extremely sensitive to color changes and is finding wide application wherever processes must be controlled by changes in color.—*Electronics.*

Ignition filter

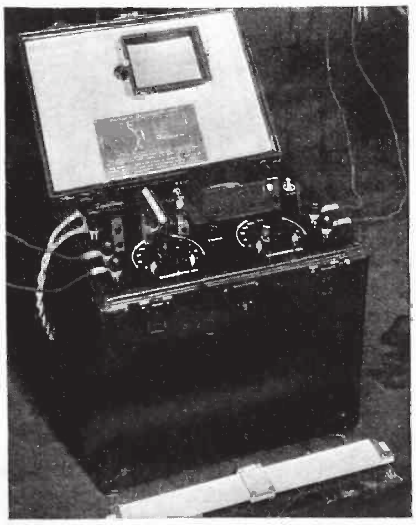
C. M. SHERWOOD & COMPANY, 80 Seventh St., Long Island City, have developed an ignition filter for the protection of automobile radio sets, which has as its feature a low resistance of only 200 ohms, in comparison with resistances up to 40,000 ohms, of other forms of spark suppressors. This low resistance insures a hot spark, according to Mr. Sherwood, and so results in improved automobile performance, eliminating loss of power and speed, production of carbon, sluggish acceleration, increased gasoline consumption, and sticky valves, all of which are caused by weak ignition sparks failing to fire the fuel gases in the cylinders.—*Electronics.*

New series F formica

A NEW PRODUCT KNOWN as Series F Formica is being offered by The Formica Insulation Company of Cincinnati, Ohio. This consists of a Formica facing in various solid colors on metal and on hardboard. The material is used for panels in cabinets of various kinds where good color, good surface, durability and resistance to chemicals and liquids of various kinds is desired. The coating on metal is flexible and will not easily chip off as occurs with many enamels used on iron. —*Electronics.*

A portable oscillograph

AN ENTIRELY NEW OSCILLOGRAPH, differing greatly from previous designs, has been developed by the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., using a new type of optical system and galvanometer. This new instrument may be used as conveniently as an ordinary voltmeter or ammeter, and has other characteristics which will extend the range of application of oscillographic instruments.



The instrument is entirely self-contained and may be operated from a 110-volt, 60-cycle lighting circuit without auxiliary attachments. The oscillograph is very compact as shown by its over-all dimensions which are 8 in. by 11½ in. by 11 in. Its total weight is approximately 18 lbs. Both galvanometers may be used for measurements of potentials up to 300 volts or currents up to 10 amperes without the use of external resistors.—*Electronics.*

Insulating sleeving

William Brand & Company, makers of electrical insulating materials, 268 Fourth Ave., New York City, have produced a new saturated sleeving which offers a very high resistance to extreme breakdown voltages. This new sleeving replaces untreated sleeving, and permits a rigid form of insulation on lead wires, etc., allowing assemblies in places where soft sleeving offers considerable difficulty. The new material remains perfectly round, and retains its resiliency. Tests made of the yellow sleeving have shown it to withstand breakdown potentials of 6,900 volts.—*Electronics.*

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Molybdenum and tungsten

The American Electro Metal Corporation, with factory at Lewiston, Maine, and offices at 65 Madison Ave., New York City, is producing very pure molybdenum and tungsten. Its molybdenum wire is made up in accordance with customers' specifications, in various diameters and in any temper, suitable for grids in radio tubes, supports for incandescent lamps, and supports for electrodes for all kinds of vacuum tubes, including X-ray tubes. A special field for ribbon and heavy wire is for electric furnaces where a high temperature is required. Molybdenum is also made in other forms, such as rods, sheets, "boats" for annealing furnaces, plates, shields for X-ray tubes, etc.

Besides molybdenum, the company supplies as a specialty tungsten rods in large quantities for the manufacture of tungsten contacts; tungsten targets for X-ray tubes and all kinds of internal parts for X-ray tubes. It has also developed a tungsten sheet with a guaranteed purity of 99.5 to 99.7 per cent. This sheet is exceptionally ductile in consequence of its purity. The sheet can be bent and stamped into shapes. It can be supplied down to a thickness of 0.050 mm. Upon special request it can be supplied as thin as 0.030 mm.—*Electronics.*

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Radio wires and cords

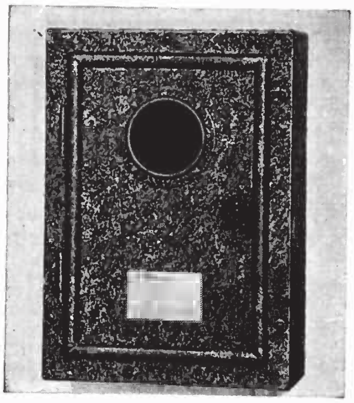
The Radolek Company, 601 West Randolph St., Chicago, is distributor for the Lenz Electric Manufacturing Company, 1751 North Western Ave., Chicago, handling its radio cords, cables and wires. These products include Lenz wire, radio speaker cords of both magnetic and dynamic types, extension cords, headset cords, microphone cables, shielded cables, and shielded antenna conductors.

Shielded cables are used in connection with automobile-radio, public-address systems, and other sound equipment. The closely woven shield of annealed tinned-copper wires acts as a static reducer and eliminates various disturbances. On account of the short aerial used with auto radios, the Lenz company builds antenna cables of ½-inch overall diameter. This is accomplished by using a cotton filler before applying the copper shield. A braid of cotton treated with weatherproofing applied over the copper shield can be furnished if desired.—*Electronics.*

◆

Elevator levelling relay

In this Westinghouse unit, having three housings, light-sensitive tubes in two outer housings are illuminated by a lamp in the center housing. Vanes in elevator shaft at floor level pass between housings, being so located as to bring car to the exact floor level. If car is off level in one direction one phototube is illuminated and if off in the opposite direction the opposite phototube is illuminated, resulting in inching of elevator motor to bring car in correct position within 1/16 inch of floor level. Some 36 of these are installed at Radio City, New York, and eighteen are installed in the new Chicago postoffice. Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.—*Electronics.*



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Wire-wound resistors

A complete line of wire-wound resistors has been placed on the market by the Atlas Resistor Company of 423 Broome St., New York City. The resistance wire is wound on special-process porcelain tubes and is of the finest grade enameled nichrome. The range of resistances available runs from 50 ohms to 100,000 ohms and varies from the small 2-watt sizes to the large 100-watt units. Special sizes can be made upon application.

By employing the pack-winding method, these resistors have been made as physically small as is consistent with good engineering practice. Owing to the special enamel varnish used, heat radiation is greatly facilitated. This insures long life and permanency of resistance values.—*Electronics.*

Microvolter

Ferris Instrument Corporation, Boonton, N. J., has developed its Model 10B microvolter as a convenient, portable unit for sensitivity measurements on radio receivers. It is intended for factory and field testing, and for much of the use in laboratory and development work where all the features of a more expensive signal generator are not needed.

It covers a frequency range of 150 to 20,000 kcs. by means of six coils included in the instrument. This permits measurement not only at broadcast and intermediate frequencies, but at practically all frequencies covered by the vast majority of aircraft, police and other high frequency receivers.—*Electronics.*

◆

Transformers, Sockets

The Central Radio Corporation, 156 Roosevelt Ave., Beloit, Wis., has developed a line of transformers and chokes designed to conserve space while providing the same or improved operating characteristics. The line includes microphone-coupling transformers, speaker transformers, filter and output chokes. Class A and Class B audio transformers are also available for any of the new tube combinations in the small dimensions which characterize the CRC line.

The company also makes the CRC socket in all types, employing heavy 26-gauge cadmium-plated clips, with extra heavy solder lugs, and strong wiping contacts.—*Electronics.*

◆

Turntable for transcriptions

The Synchro-Motive Instrument Company, Chrysler Building, New York City, has developed turn-table equipment for reproducing broadcast transcriptions, which gives accurate speed regulation "without waver."

The equipment is made in three different models, Model "ST" is a 33⅓ r.p.m. synchronous motor used for reproducing 33⅓ r.p.m. recordings only. Model "CT" is a combination 33⅓ and 80 r.p.m. synchronous motor for reproducing both 33⅓ and 80 r.p.m. records. Model "DCT" is a combination of two model "CT" units, and is equipped with a mounting panel for fading controls. With this model it is possible to fade from 33⅓ to 80 r.p.m. recordings through the same mixing circuit, without making any changes in the pick-up input circuits.

The change in speed is controlled by a switch. These machines can be supplied with Audak pick-ups to play lateral and vertical-cut records.—*Electronics.*

B power device

The B-power supply unit produced by Herman A. DeVry, Inc., 1111 Center St., Chicago, Ill., is not merely a vibrating interrupter, but a means of obtaining a true alternating current from a battery source. The frequency (150 cycles) remains constant under wide variations of d.c. input voltages, as the frequency is directly dependent upon the weight and tension of the armature.

Being compound-wound, the unit provides automatic voltage regulation under varying load conditions. This is accomplished by automatically increasing the amplitude of the vibrating armature when the transformer secondary load is increased.

The variation of current in the primary of the power transformer is dependent upon the pressure and resistance of the contact surfaces. Increased pressure caused by the increase in amplitude raises the primary voltage when the secondary load is increased.

The standard DeVry B power supply for auto radio sets delivers 220 volts at 40 mils. The unit in the DeVry sound-on-film recorder delivers 650 volts at 40 mils. The same converter unit may be adapted to many other electronic devices.—*Electronics.*

✦

Motor overload protection

FOR THE OVERLOAD PROTECTION of fractional-horsepower single-phase motors, the Square D Company, industrial controller division, Milwaukee, Wis., offers the new "Knockout" overload breaker. It is designed to mount on and wire into a standard $\frac{1}{2}$-in. knockout. The case is made of bakelite and the overall dimensions are only $2\frac{7}{16}$ in. high, $1\frac{3}{8}$ in. wide and $1\frac{3}{4}$ in. deep. The breaker is of the thermal, melting-alloy type. After an overload trips the breaker, it is reset from an indicating button; no replacement parts are required. The contacts are silver to silver, single pole, double break. The maximum rating is $\frac{3}{4}$ hp., 110 or 220 volts, a.c.—*Electronics.*

✦

Rectifiers

THE SQUARE D COMPANY, Detroit, Mich., has increased its copper oxide and tube rectifiers.

The Square D "Rectifilter" converts alternating current to direct current merely by connecting the input to any regular a.c. source of supply. Models are manufactured to power any equipment requiring d.c. Units delivering output with a degree of a.c. component down to 0.0002 volts are available. Such requirements as telephone switchboards, signal and clock systems, fire and police signal systems, sound-on-film and broadcasting can be supplied.

One of the new Rectifilter units equipped with a copper-oxide dry-plate rectifier, is designed for telephone switchboard service and delivers 24 volts at 2 amperes from a 115-volt a.c. source.

Another model, designed particularly for apartment house telephone and other interphone systems, because of the simplicity of the Rectifilter design, can be stocked by dealers and installed within a few minutes in place of batteries by connecting the a.c. line and the d.-c. load to the proper terminals. —*Electronics.*

✦

Crystal microphones

THE BRUSH DEVELOPMENT COMPANY, 3715 Euclid Ave., Cleveland, Ohio, has developed a new line of Brush grille-type microphones, employing Rochelle-Salt crystals. These microphones employ a new principle which, the makers believe, will prove revolutionary in sound production. Moreover, in employing this new principle, the line of microphones gets away from the difficulties which are inherent in diaphragm types, inasmuch as the sound-wave passes through the microphone with no subsequent distortion due to pressure doubling or cavity resonance.

The following types are now available:

Type G-20—The general-purpose studio microphone. It consists of twenty "sound cells" connected to give the required output—mounted in monel-metal cage and plug.

Type G-1—Single "sound cell" in case, must be within about 30 ft. of pre-amplifier. Ideal where microphone must be concealed in film recording, for announcing, for use in parabola and as "lapel" microphone.

Condenser head substitutes may be used to replace present condenser head in amplifier, converting condenser into crystal microphone, doing away with frequent adjustments and greatly improving the response.—*Electronics.*

✦

Condensers

THE NEW "SURGPROOF" line of condensers, developed by the Tobe Deutschman Corporation, Canton, Mass., includes many radically new condenser units that will meet every service requirement. The experience obtained from the development of Tobe "Filterettes," in which condenser failures absolutely cannot be tolerated under any circumstances, has fostered the production of the "Surgproof" condenser which, as its name signifies, has a safety factor great enough to allow the condenser to withstand the surges and transient voltages that are responsible for so many condenser breakdowns.—*Electronics.*

Transfer relay

WARD LEONARD ELECTRIC COMPANY, Mount Vernon, N. Y., announces a relay adaptable to applications where the circuit requires up and down contacts separate from each other. It is particularly suitable for transfer purposes where it is necessary, upon operation of the relay, that one or more circuits open and one or more separate and independent circuits close.

The relay is equipped with four poles, two of which are normally open and two normally closed. Contacts may be easily rearranged for single-pole operation.

Stiff-metal switch blades, or contact fingers, spring shackled and equipped with ample size silver-to-silver contacts to allow a comparatively high ampere rating make the relay a desirable unit for heavy duty relay or light duty contactor service.—*Electronics.*

✦

Soldering-iron pyrometer

THE CORRECT TEMPERATURE at the tip of a soldering iron varies with the kind and size of the work and the rate at which the operation is being done. If the temperature which gives the best results is known for a certain class of soldering work, the source of heating energy or the size of the iron used may be varied to give this desired temperature continuously, thus avoiding all trouble due to underheated or overheated irons.

The Weston Electrical Instrument Corporation, Newark, N. J., has a model 659 pyrometer which indicates the temperature of the soldering iron tip accurately and quickly. The instrument consists of a $3\frac{1}{4}$-inch panel type meter connected to a special thermocouple, which is located in a small bead of solder at the center of a lava disc on the base of the stand. Its scale is calibrated 32 to 800 degrees Fahrenheit.

To measure the temperature of the soldering iron tip it is only necessary to place the tip in contact with the solder on the disc which becomes melted and transmits heat to the couple. This causes the instrument to indicate directly the temperature of the iron itself. The readings obtained are practically instantaneous.—*Electronics.*

U. S. PATENTS

IN THE FIELD OF ELECTRONICS

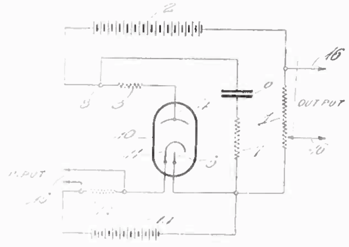
Electron Tube Applications

Voltage indicating apparatus. A d-c source, the voltage of which is to be kept within a desired range and the method by which glow tubes can be connected across various portions of this voltage, one tube breaking down when a voltage reaches the upper limit of the desired range and the other tube breaking down when the voltage reaches the lower limit. P. H. Crago, assigned to Union Switch & Signal Co., filed March 29, 1932. No. 1,918,834.

Cathode-ray sweep circuit. Method of producing stationary images of re-current alternating waves consisting in electrostatically locking the sweep frequency with the phenomena to be observed. F. G. Patterson, assigned to G. E. Co., filed July 23, 1931. No. 1,919,985.

Thunderstorm indicator. Method of indicating the presence of electrostatic charges, such as thunderstorms or electric field potentials. Ross Gunn, Washington, D. C. Filed March 17, 1930. No. 1,919,215.

Frequency division system. A three-element gaseous discharge tube, condensers, etc., for effecting divisions in frequency energy. R. M. Page and W. F. Curtis, Washington, D. C., filed Dec. 24, 1930. No. 1,919,251.



Signal control for demand meters. Combination of a three-element tube and a demand meter. James Hyslop, Terre Haute, Ind., filed Dec. 27, 1932. No. 1,919,514.

Distance determination. Method for measuring distance by means of sound waves including time delays and amplifying tubes. Charles Eisengapf, assigned to Siemens & Halske. No. 1,919,015.

D.c.-a.c. system. Apparatus for transmitting energy between direct and alternating current circuits comprising thermionic tubes and a transformer with a-c and d-c windings. G. A. Sabbah, assigned to G. E. Co., No. 1,918,870.

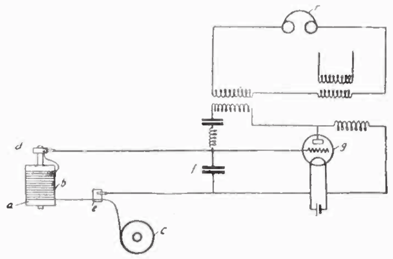
Power converting apparatus. Method using vapor discharge tubes, resonant circuits or charged capacitator circuits for providing a.c. from d.c. No. 1,919,976 and 1,919,977 to A. S. Fitzgerald, assigned to G. E. Co.

Vacuum interrupting apparatus. A circuit interrupter comprising a highly evacuated envelope and electrodes capable of being moved. D. C. Prince, assigned to G. E. Co. No. 1,919,987.

Electrical measurement circuits. Method of comparing an unknown impedance with a known impedance by means of a tube bridge circuit. G. A. Stone, assigned to Central Scientific Co., filed Oct. 27, 1931. No. 1,919,538.

Sorting device. Operation of a number of light sensitive cells in series for sorting articles. V. K. Zworykin, assigned to W. E. & M. Co., June 16, 1927. No. 1,922,188.

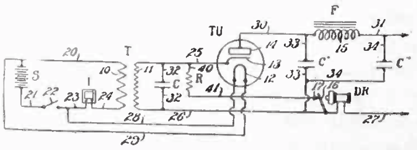
Manufacturing accurate inductance. A method of winding inductance coils having accurate predetermined inductance value by connecting the coil to an oscillator during the winding, varying the frequency of oscillation in accordance with variation in the inductance of the coil, comparing the frequency produced with a standard frequency and arresting the coil forming operation when the varying frequency reaches a predetermined value. W. F. Ewald, assigned to Telefunken, Sept. 19, 1930. No. 1,921,869.



Gyro system. An electrical non-contacting thermionic tube follow-up system for gyroscopic compasses. D. A. Whittkuhns, assigned to Sperry Gyroscope, Nov. 4, 1930. No. 1,921,983. See also No. 1,921,982 to Sperry on a remote control system.

Control circuits. Patents Nos. 1,921,786 to 1,921,789 inclusive to C. G. Suits, assigned to G. E. Co., filed between January and July, 1932, on non-linear circuits, saturable core reactor apparatus, etc.

B. eliminator protection. A step-up d-c converter comprising a transformer, an interrupter and a rectifier with a relay connecting across the filter connection a resistance approximating the normal output load which is removed when the normal load is put on the tube. W. W. Garstang, Indianapolis, Ind., July 30, 1932. No. 1,921,461.



Radio Circuits

Wave repeating system. Method by which signals from a local broadcasting station can be picked up at a receiver station and relayed to another receiver on a different frequency. Each receiver station uses directive receiving and transmitting antennas and somewhat different frequencies for receiving and transmitting. A. N. Goldsmith, assigned to R.C.A. Filed April 30, 1932, No. 1,918,262.

Short-wave broadcasting. A receiving system for relaying signals of the order of one meter or so using directive transmitting and receiving antennas. Fritz Schröter, assigned to Telefunken. Filed April 5, 1930, No. 1,918,291.

Multi-element tube circuit. Radio receiver using a multiple function tube having elements of an amplifier and two rectifiers with circuits for rectification, automatic volume control, and a-f amplification. P. O. Farnham, assigned to R. F. L., Inc. No. 1,919,160, filed Nov. 4, 1932.

Remote-control circuit. Patents granted to Bowden Washington and Wilson Aull, Nos. 1,918,674 and 1,918,683, assigned to Remotrole Corp., on methods for remotely operating and controlling radio receivers.

Automatic control system. Method by which at least two independent station selector switches can be operated which will tune all the circuits in a receiver to the desired station. W. V. B. Roberts, assigned to R.C.A., filed June 27, 1929. No. 1,918,826.

Stabilized receiver. Method for using the capacitance between stators of tuning system condensers for producing variable feed-back for neutralization at the short-wave end of the spectrum. W. V. B. Roberts, assigned to R.C.A., filed April 15, 1929. No. 1,919,906.

Interference suppressor. A band-pass filter system for selecting desired electrical oscillations of a given frequency band and suppressing frequencies outside of this band. L. L. Jones, Oradell, N. J., filed March 6, 1928. No. 1,919,948.

Radio direction finder. A two-loop system with a commutating means for reversing the direction of one of the loops. H. Antranikian, Paris, France. No. 1,920,159.

Amplification, Generation, etc.

Sound and image transmission. Simultaneous transmission of electric currents, one having a characteristic corresponding to the appearance of a speaker and the other variation corresponding to his speech. F. M. Ryan, assigned to B.T.L., filed April 19, 1927. No. 1,919,804.

Image reproducing system. Method of reproducing a picture at a distance comprising projecting a moving scanning light spot of constant intensity upon a first picture reproducing screen and moving a second screen relative to the first screen. J. J. Rogan, assigned to Hygrade Sylvania Corp., filed Nov. 22, 1929. No. 1,918,827.

MOLDED CARBON VOLUME CONTROL

by

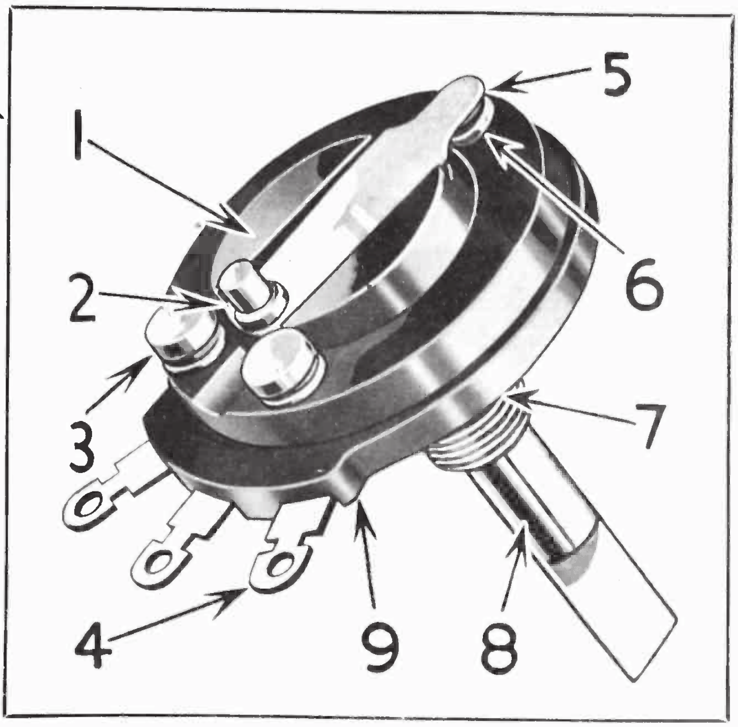
STACKPOLE – –

Keeps pace with Radio Progress

9

FEATURES

of design which promote performance



1 Protection offered in fully insulated bushing and shaft

A bakelite hub carries the spring arm and the contact for the moving element. The shaft is molded into the other end of this bakelite hub. Mounting bushing and shaft are thus fully insulated from entire Control Resistor.

2 Accurate switch operation

The cam dog which operates the A.C. switch on switch type variable resistors, is assembled as a composite part of the moving arm member. Accurate switch operation in respect to the resistance curve or hop-off value is assured.

3 Stable and solid assembly

Rugged stop pins are accurately located through the resistor element and the bakelite frame and hold the entire assembly into one solid form.

4 Easy assembly

The lugs of the resistor as well as those on the AC Switch are tin dipped to facilitate the soldering of connecting wires.

5 Smooth action and noiseless
6 operation

A one-piece special tempered spring arm maintains constant spring tension against a nickel chrome, highly polished, non-corrosive sliding shoe. Smooth and easy rotation of the variable resistor arm is assured.

7 Simple mounting

A standard brass bushing for one-hole mounting is fully insulated from the arm and resistor element.

8 Quiet, easy operation

The shaft is of non-rusting cadmium plated steel, perfectly fitted in the bore of the brass bushing to provide smooth and quiet operation.

And

9 *A New, Permanent, Molded Carbon* RESISTOR ELEMENT

Stackpole offers the first control of its type and the first compact variable resistor which is permanent and unaffected by humidity.

The thick molded carbon resistor element, mounted on bakelite frame, is made in much the same way as permanent carbon resistors. Its hard glass-like surface is the result of firing at high temperatures and assures imperviousness to humidity—hard usage and varying temperatures. Stackpole Molded Carbon Volume Controls will carry considerable current, are free from capacity effect, and have low heat and voltage coefficient. They are smooth and quiet in any circuit.

Made in any value from a few hundred ohms to a couple of megohms with any desired resistance taper and any hop off or fixed value of resistance at either or both ends.

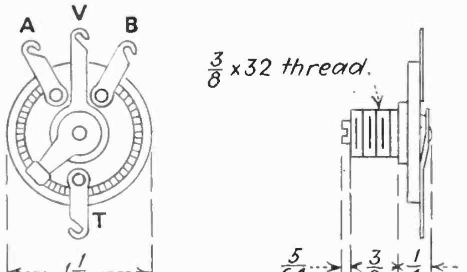
STACKPOLE CARBON CO.

ST. MARYS, PA.

More than 50% of the new radio sets made today use Stackpole fixed Carbon Resistors in their initial production.

This trademark is assurance that your receivers will not "come back" because of resistor troubles.

Check your specifications and prices against Clarostat volume and tone controls, ballasts, metal can resistors, M. H. Potentiometers, etc., etc.



Metal Can Resistors—Clarostat offers a complete line of asbestos covered, enclosed in metal can resistors. They may be had in straight resistors, tapped resistors and in many other varieties.

They are so constructed to mount flush to the chassis; or raised off the chassis to your specifications; or upright mounting position; the entire height not exceeding the height of the radio set's tubes.

M. H. Potentiometers—Equipped with screw driver or standard knob adjustment, extremely compact. Power rating—One watt; Resistance range—10 to 1,000 ohms; Tolerance—Overall plus or minus 10%, Tap plus or minus 10%.

With the uncertain price situation, now is the time to check all your resistor requirements against Clarostat prices and quality. Wire or write for details.

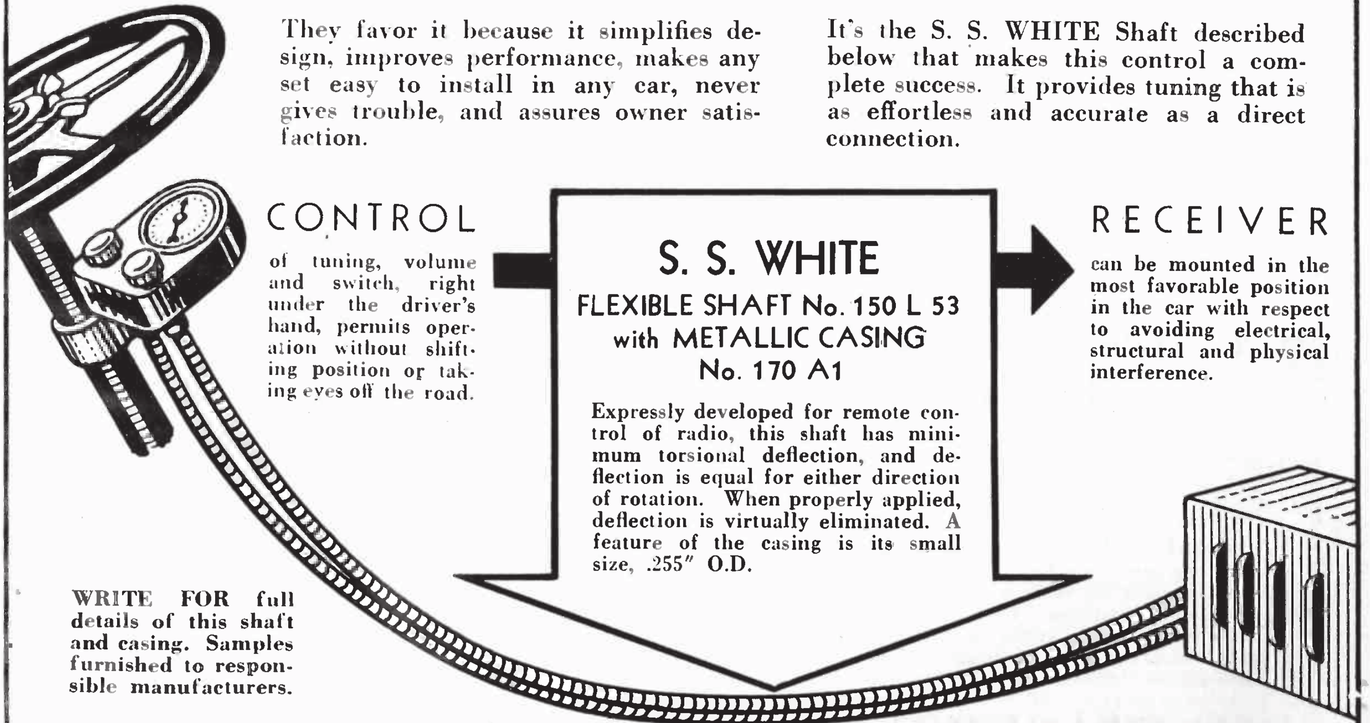
Clarostat Manufacturing Co., Inc.

285 North 6th Street, Brooklyn, N. Y.

Leading Auto Radio Manufacturers are using this **Effortless, Accurate, Safe** control

They favor it because it simplifies design, improves performance, makes any set easy to install in any car, never gives trouble, and assures owner satisfaction.

It's the S. S. WHITE Shaft described below that makes this control a complete success. It provides tuning that is as effortless and accurate as a direct connection.



CONTROL

of tuning, volume and switch, right under the driver's hand, permits operation without shifting position or taking eyes off the road.

S. S. WHITE

FLEXIBLE SHAFT No. 150 L 53 with METALLIC CASING No. 170 A1

Expressly developed for remote control of radio, this shaft has minimum torsional deflection, and deflection is equal for either direction of rotation. When properly applied, deflection is virtually eliminated. A feature of the casing is its small size, .255" O.D.

RECEIVER

can be mounted in the most favorable position in the car with respect to avoiding electrical, structural and physical interference.

WRITE FOR full details of this shaft and casing. Samples furnished to responsible manufacturers.

The S. S. WHITE Dental Mfg. Co. INDUSTRIAL DIVISION

Knickerbocker Bldg.
New York, N. Y.

New . . . a complete line of Graphite Anode Tubes by

Sylvania

(Reg. U. S. Pat. Off.)

Hygrade Sylvania Corporation, through its newly established Electronics Department, is now in production on a complete new line of transmitting tubes which are revolutionary in design. They employ the new graphite anode structure conceived and perfected by the engineering organization of Hygrade Sylvania Corp. To the many inherent good features of the Sylvania line, the graphite anode adds the following major advantages:

1. High plate dissipation without overheating. This is a direct result of the high thermal emissivity of graphite.
2. Lower operating temperature at the anode. This results in a lower operating temperature of the other electrodes, thereby preventing secondary and primary emission from the grid.
3. Uniformity of characteristics. The physical properties of graphite permit exact processing. Graphite does not warp under high temperatures and the mechanical dimensions of the anode remain constant. Proper relation between tube elements retained in this manner, preserve the normal electrical characteristics of the tube.
4. Long life. Comparative freedom from gas is another important effect of the graphite anode and the high vacuum obtainable results in longer tube life.

A process developed in the Electronics Laboratory of Hygrade Sylvania Corporation enables us to treat carbon in such a manner that it is reduced to pure graphite with all amorphous carbon and other impurities removed.

Early this year Hygrade Sylvania Corp. established a separate new plant in Clifton, N. J., for the design and production of radio transmitters, transmitting tubes, industrial power tubes, and custom-built electronic devices. This plant contains most modern research and manufacturing facilities. Unhampered by obsolete dies, processes and routine, Hygrade Sylvania has been able to go exclusively now to this revolutionary new design.

HYGRADE SYLVANIA CORPORATION

ELECTRONICS DEPARTMENT

Hygrade Lamps **Sylvania Tubes**

CLIFTON, NEW JERSEY

FACTORIES

SALEM, MASS. EMPORIUM, PA. ST. MARYS, PA. CLIFTON, N. J.

WAREHOUSE FACILITIES IN

PORTLAND, ORE. CHICAGO, ILL. PHILADELPHIA, PA. LOS ANGELES, CAL. ATLANTA, GA. SALEM, MASS. NEW YORK, N.Y.

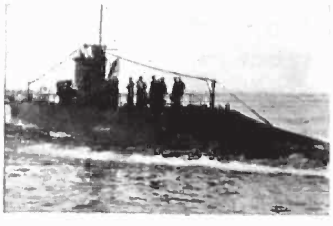
NRA MEMBER U.S. WE DO OUR PART

THEY QUALIFY!

Constant use in all parts of the world, almost instantaneous change from freezing cold to tropical heat, extreme dryness and intense humidity—these are but a few of the factors to be considered in airplane radio equipment.

Here all the adverse conditions met with in years of ordinary radio use—plus many new ones besides—may be encountered in a few short hours. Here, precious human lives and the completion of important schedules may depend on the ability of resistors to function properly at all times.

Yet standard IRC Resistor units meet all requirements. You'll find them specified by leading air lines—find them in daily use from Alaska to Montevideo, from Los Angeles to New York, from Hong Kong to Peiping. Not only do they qualify by test—they excel in actual year 'round performance in this, the most exacting of all resistor proving grounds.



SUBMARINES, TOO

Far below the surface of the sea as well as in the air, IRC units will be found in daily use—delivering 100% resistor performance under the most adverse conditions. Certainly no better practical demonstration of quality could be asked for the resistors specified for your own product regardless of where or how it is to be used.

Write for literature on IRC Resistor construction and performance. Or, if you have special resistor problems, let IRC engineers help you solve them as they have done for many others.

NRA MEMBER U.S. WE DO OUR PART

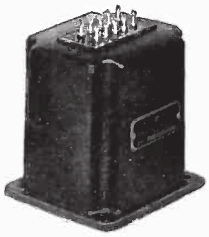
INTERNATIONAL RESISTANCE CO.
2100 Arch St., Philadelphia, Pa.
In Canada, 74 Wellington St. W., Toronto, Ont.

KENYON **PRODUCTS**

Specify KENYON TRANSFORMERS!

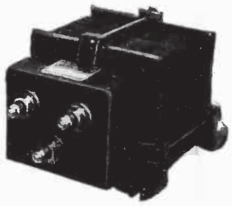
Because KENYON ranks among pioneer transformer specialists. All parts manufactured in KENYON plant, including coil winding. Electrical and mechanical characteristics of both raw materials and finished units constantly checked by completely equipped research laboratory. From start to finish, nothing is overlooked, skimped, forgotten. That's why KENYON means transformer quality at the right price for lasting satisfaction. Thus . . .

• *for* Laboratory Standards



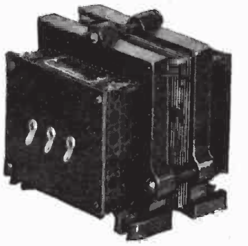
KENYON Laboratory Standard Audio Components meet highest standards. Really flat curve in components and assemblies. High efficiency attained through proper and liberal proportioning of materials. Housed in high-permeability cast-iron cases. Cross-talk proof. No. A.C. hum pickup. Electrostatic shielded coil structure. Thoroughly vacuum-impregnated and sealed against moisture and climate. Complete line for all needs.

• *for* Dependable Power Packs



Compact but husky power transformer supplying combined filament and plate voltages. Also filament transformers, center-tapped secondaries. Conservatively rated for continuous, troubleproof operation. Likewise reactors or choke coils, Complete KENYON rectifier assemblies made to order, as well as voltage regulators.

• *for* Long-Life Transmitters



Conservatively rated components manufactured for many years for broadcast and amateur transmission. Any voltage and any current output can be met. Filter and plate transformers, also filter and modulation reactors. Highest quality both in performance and in handsome appearance. KENYON components are used in many transmitters the world over.

• *And* for Any Special Purpose

In addition to the complete line of standard radio transformers and chokes, the KENYON engineering and production departments are ready to design and make special equipment for any radio, laboratory, electrical or industrial need. No job is too large; none is too small. Just try KENYON!

Send for Catalog covering the standard line of KENYON radio transformers and chokes. And do not hesitate to place your transformer problems before our engineers, or to send along your specifications for our quotations.

NRA MEMBER U.S. WE DO OUR PART

KENYON TRANSFORMER CO., Inc.
122-124 Cypress Ave. - - - - - New York

Steatite

unsurpassed as a high-frequency ceramic dielectric is now commercially available for service in the products of manufacturers in the electronics and communications industries.

Tried and perfected during nearly half a century of development and manufacture, Steatite is today placed at the disposal of engineers in a form best suited to their requirements. Lower in radio frequency loss than any insulator in its particular class, remarkably strong, resistant to fracture, and non-hygroscopic, Steatite may be cast, machined, extruded or moulded in a variety of shapes and sizes to specifications.

The Dielectric Products Company, in association with the General Ceramics Company, the largest producer of its kind in America, will engage in the development, manufacture and marketing of Steatite compositions for application to all branches of the electronic and communications industries. Complete engineering data, cost and delivery information will be furnished promptly in response to general inquiries as well as to definite specifications.

●

J. L. Bernard and H. T. Carey, formerly of Isolantite, Inc., are now associated with the Dielectric Products Co., in New York.

PROPERTIES

Power Factor	.09-.20%*
Dielectric Constant	5.0-5.8*
Water Absorption After 24 Hrs. Immersion	None
Tensile Strength	7,850–12,000 lbs./sq.″
Transverse Strength	17,000 to 19,800 lbs./sq.″

* Actual value depends upon frequency, temperature and composition.

DIELECTRIC PRODUCTS COMPANY

11 Park Place
New York, N. Y.

AmerTran Announces

New Lower Prices Improved Designs

of AmerTran De Luxe Transformers

AmerTran De Luxe Transformers listed below are of the same high quality as similar units manufactured during the past 10 years but prices have been considerably reduced and designs have been revised to permit full advantage of new tube ratings. They are recommended as the best available standard equipment for use in precision amplifiers in broadcasting stations, recording studios, and laboratories.

New AmerTran SilCor Audio Transformers

of modern design at popular prices

AmerTran SilCor Transformers have been developed to satisfy the demand for quality audio transformers at popular prices. They are similar in design and construction to "De Luxe" transformers but have core laminations of silicon steel instead of high permeability alloy. They are highly satisfactory for all usual requirements in public-address equipment and other commercial requirements.

	DE LUXE LINE		SILCOR LINE	
	Type No.	List Price	Type No.	List Price
Interstage: 1 pl. to 1 gr., 0 dB	D-12	$7.00	J-711	$4.50
Interstage: 1 pl. to p/p gr., 10 dB	D-21	8.50	J-721	5.00
Interstage: p/p pl. to p/p gr., 18 dB	D-51	10.00	J-751	6.00
Input: 200 or 500 w. to 1 gr., 0 dB	D-81	10.00	J-771	5.50
Output: 1-227 pl. to 200 or 500 w., 10 dB	D-31	8.50	J-731	5.50
Mixer: 200 or 500 w. to 200 or 500 w., 0 dB	D-91	8.50	J-791	5.50
Output: p/p 2A3 pl. to 15/7½/5/3¾ w., 34 dB	D-64	18.00	J-822	5.50
Output: p/p 2A3 pl. to 500 and 15 w., 34 dB	D-103	18.00	J-752	5.50
Output: 500 w. to 15/7½/5/3¾ w., 34 dB	D-135	18.00	J-831	8.00

NOTE: Above tabulation lists only nine popular types—complete catalog on request. List Prices effective August 1, 1933.

American Transformer Company

Transformer builders for over 31 years

178 Emmet St., Newark, N. J.

AMERTRAN TRANSFORMERS

Improved REMOTE CONTROL FLEXIBLE SHAFTS *for* RADIO

Automotive Pioneers—Since 1905 this organization has pioneered and sold a major part of speedometer shafts for the automotive industry. With its large facilities, it can assure quality and prompt delivery of auto radio remote control shafting.

Hundreds of Thousands of Feet of Fischer Remote Control Cables and Casings are now giving satisfactory duty in sets on the road. The sealed and squared Cable ends have won over scores of manufacturers to its use because of its ease in attaching more firmly to shaft tips and when used direct under set screw there is no possibility of unraveling.

The flexible Cables have the proper number of wire strands to eliminate back lash and give instantaneaus adjustment. The special twin ply Casing for the protection of the Cable is finely finished in black enamel. This perfect combination of Cable and Casing can be made in any desired size and length to given specifications.

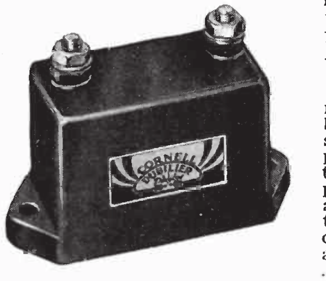
Wire or write for samples and individual design data.

***The* CHAS. FISCHER SPRING CO.**

240 KENT AVE., BROOKLYN, N. Y.

Mica Condensers

For radio transmitter, laboratory, tube plant bombarder, high-frequency oscillator—no matter what your needs—there is a Cornell-Dubilier Mica Condenser. For instance:



Here is a popular priced mica condenser. Molded bakelite case. Rugged. Constant capacity. Moisture-proof. Extremely low electrical losses. Ideal for low-power transmitters, radio and audio circuits, laboratory apparatus, bridge circuits, etc. 1000, 2000, 3000 and 5000 volt A.C., .00005 to .10 mfd. units.

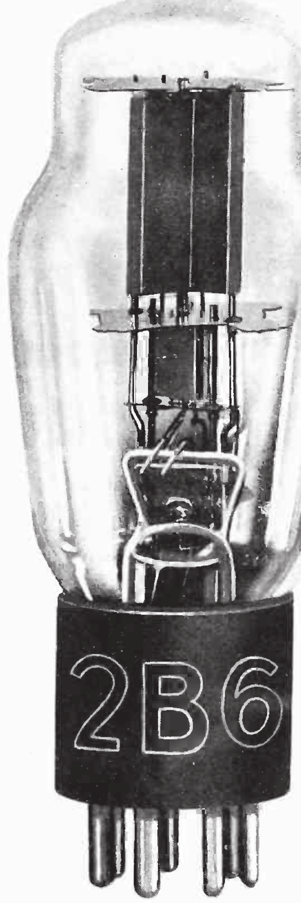
Just one of a large line of Cornell-Dubilier Mica Condensers for every radio, electronic and industrial purpose.

Write for new 1933 catalog covering the combined Cornell and Dubilier lines of condensers.

CORNELL-DUBILIER CORPORATION

4377 Bronx Boulevard New York City

1934 AUDIO-QUALITY



Super Triode

4 WATTS POWER OUTPUT •

HIGH SENSITIVITY •

Low Set Manufacturing Cost •

Technical Data Mailed Upon Request
Write

JRC
JOHNSONBURG RADIO CORPORATION
JOHNSONBURG, PENNA.

Licensed by RCA and Revelation Patent Holding Co.

SHAKEPROOF

GIVE YOUR PRODUCT THE "VIBRATION CONTROL" TEST!

Send today for your free copy of this complete Shakeproof Catalog. Explains thoroughly the many advantages that Shakeproof offers—also shows new patented Shakeproof products.

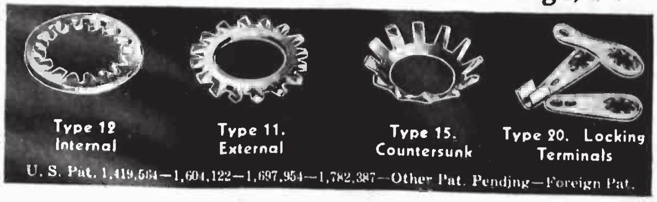
IF you would like to know how Shakeproof can improve the performance and lasting satisfaction of your product—make this simple test. First, equip one of your products with Shakeproof Lock Washers and pack it in a shipping case along with another taken from your regular stock. Then, turn these over to your shipping department with instructions to give them plenty of rough handling—just like the treatment they might experience in shipment to a dealer. Next, unpack them and examine each connection—what you see will tell you more about Shakeproof protection and why it cuts down complaints and repair costs than anything we can say. See for yourself—send for testing samples today!

"It's the Twisted Teeth that LOCK"

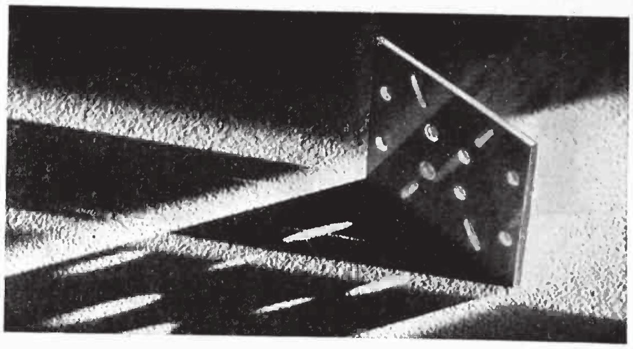
SHAKEPROOF
Lock Washer Company

(Division of Illinois Tool Works)

2539 N. Keeler Ave. Chicago, Ill.



U. S. Pat. 1,419,564—1,604,122—1,697,954—1,782,387—Other Pat. Pending—Foreign Pat.



For critical buyers of LAMINATED BAKELITE

Use of the most advanced automatic control equipment and the finest of raw materials, including genuine Bakelite resins, enable us to produce "Lamicoid" Laminated Bakelite parts which meet the severest specifications.

Ask us for samples of parts we have made for radio manufacturers and others. You are sure to be impressed by their clean-cut edges, fine workmanship, and other highly desirable qualities.

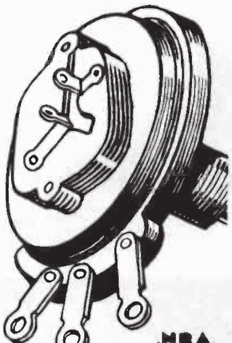
"Lamicoid" is furnished in various types, finishes and thicknesses; in fabricated form; and in sheets, tubes and rods.

MICA INSULATOR COMPANY

200 Varick Street, New York, N. Y.; 542 So. Dearborn Street, Chicago, Ill; 1330 Schofield Building, Cleveland. *Branches at* Birmingham, Boston, Cincinnati, Los Angeles, San Francisco, Seattle. *Canada:* Montreal, Toronto.

In all Volume Control design consider...

AQUADAG
REG. U. S. PAT. OFF.
COLLOIDAL-GRAPHITED WATER



Forms on solids homogeneous, conducting coatings of graphite which are chemically inert.

The resistance can be readily varied by merely increasing or decreasing the concentration of the solution employed.

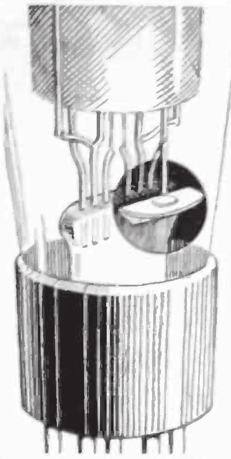
Colloidal-graphited water is achieving increased importance as a means for forming conducting, inert surfaces on the interior and exterior of glass envelopes of electronic devices.

For further details send for Technical Bulletin A11

ACHESON OILDAG COMPANY
PORT HURON, MICH.

REG. U. S. PAT. OFF. dag COLLOIDAL GRAPHITE PRODUCTS

REDUCES MATERIAL AND LABOR COSTS--- INCREASES PRODUCTION



The New BAREX

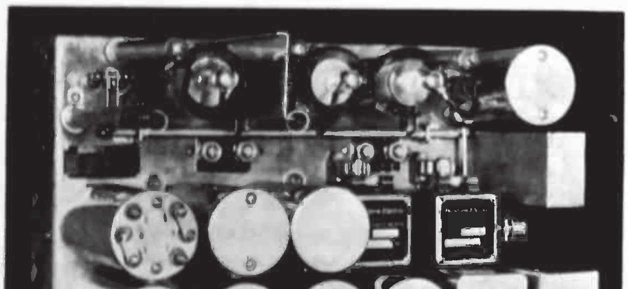
Reg. U. S. Pat. Off.

IMBEDDED GETTER

Manufactured under letters patent No. 1922162.

A new type Barium Getter, securely bonded as integral part of metal flag—vaporizes completely, minimizes splash—for all tubes. Reduces shrinkage substantially—ask about it.

KING LABS., INC.
237 W. Division Street,
SYRACUSE, N. Y.
Export Dept., 90 West St., New York, N. Y.



Western Electric 12-A two frequency superheterodyne aircraft receiver showing Elastic Stop Nuts used as standard throughout.

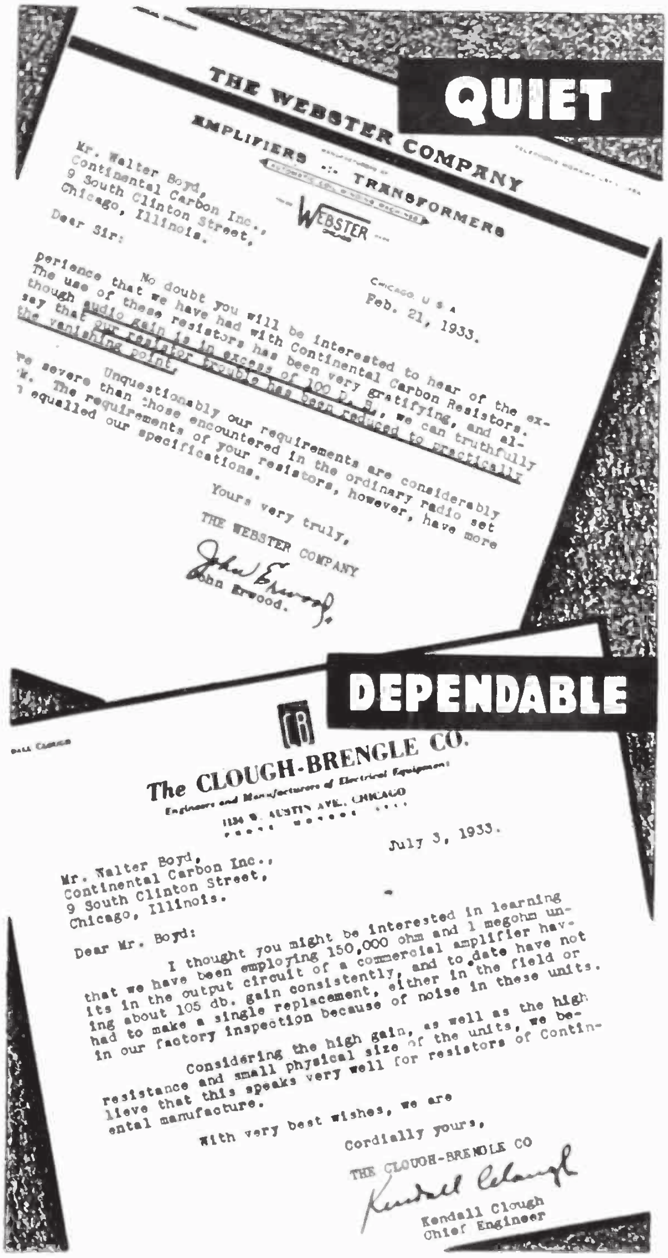
THERE is more dependable performance when radio apparatus is Elastic Stop Nut equipped.

Electrical terminal connections held with Elastic Stop Nuts are permanent and have low contact resistance. This lock nut will maintain balancing condenser adjustments for keeping the sensitivity and selectivity of high grade apparatus. Microphonic noises are eliminated on chassis mechanical connections held with Elastic Stop Nuts. Speaker rubber mountings fastened with Elastic Stop Nuts do not work loose.

Elastic Stop Nuts eliminate "loose nut" troubles on any equipment subject to vibration. Users in the electronic field include manufacturers of broadcast receivers, aircraft apparatus, automobile sets, and contractors to the government signal services, etc. Write for technical details.

ELASTIC STOP NUT DIVISION
A.G.A. CO.
ELIZABETH, N. J.

Where resistor service is exacting—they say CONTINENTALS are the most—



THE WEBSTER COMPANY
AMPLIFIERS :: TRANSFORMERS
WEBSTER

CHICAGO U S A
Feb. 21, 1933.

Mr. Walter Boyd,
Continental Carbon Inc.,
9 South Clinton Street,
Chicago, Illinois.

Dear Sir:

No doubt you will be interested to hear of the experience that we have had with Continental Carbon Resistors. The use of these resistors has been very gratifying, and although audio gain is in excess of 100 D. B., we can truthfully say that our resistor trouble has been reduced to practically the vanishing point.

Unquestionably our requirements are considerably re severe than those encountered in the ordinary radio set k. The requirements of your resistors, however, have more n equalled our specifications.

Yours very truly,
THE WEBSTER COMPANY
John Erwood.

The CLOUGH-BRENGLE CO.
Engineers and Manufacturers of Electrical Equipment
1134 W. AUSTIN AVE., CHICAGO

July 3, 1933.

Mr. Walter Boyd,
Continental Carbon Inc.,
9 South Clinton Street,
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Dear Mr. Boyd:

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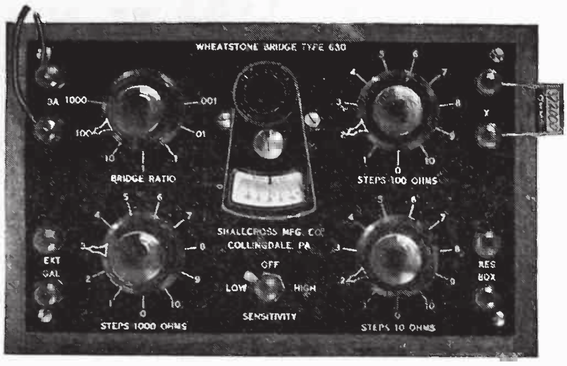

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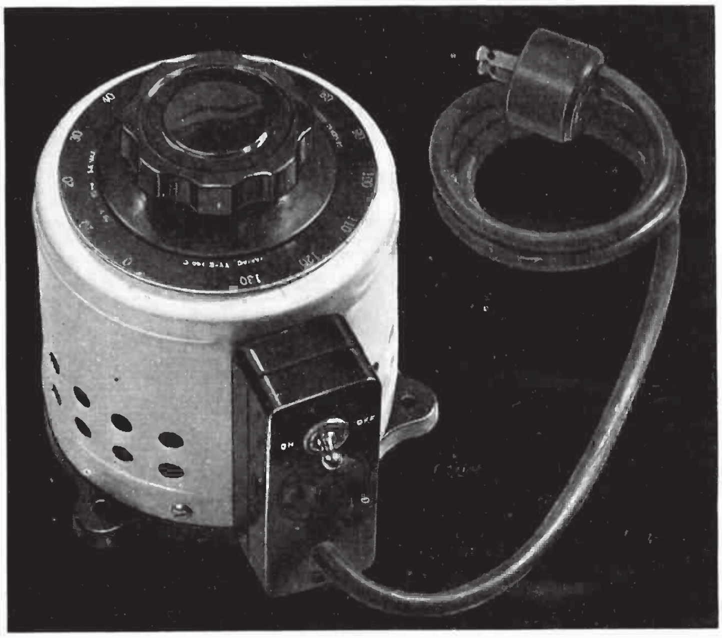

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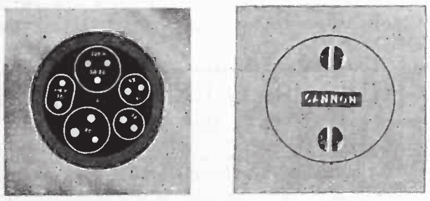

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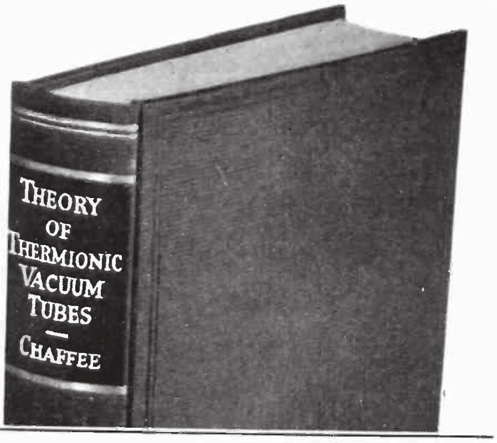

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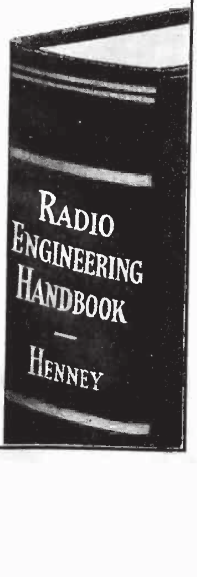

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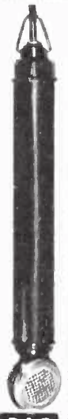

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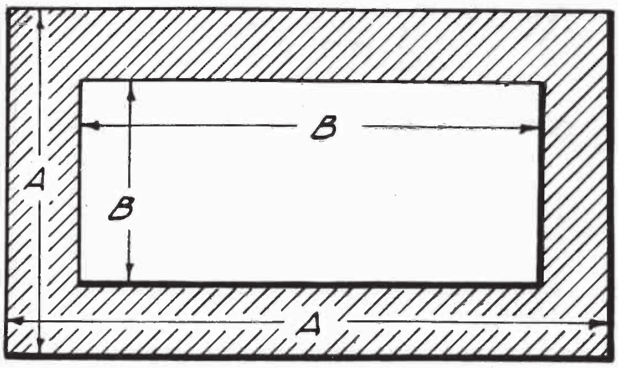
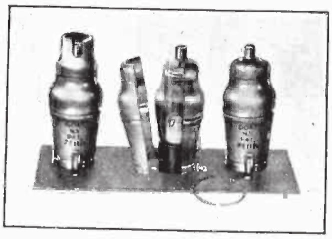


"A" showing size of chassis required for the old-fashioned "can" shields.

"B" relative size of the same chassis equipped with GOAT TUBE SHIELDS.



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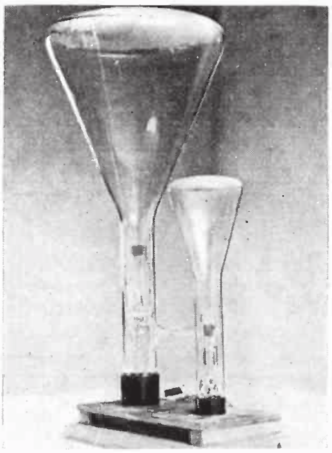

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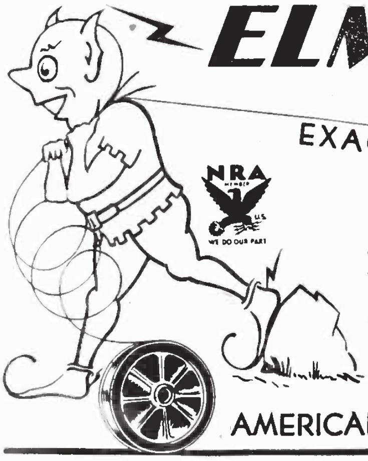

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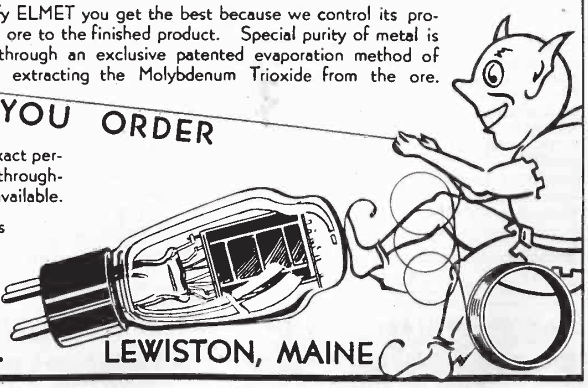

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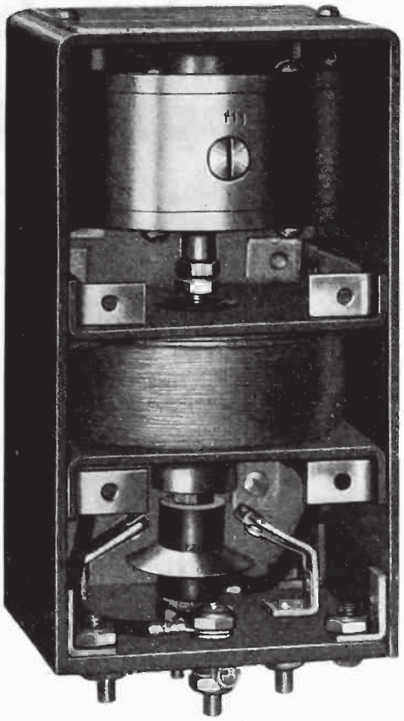

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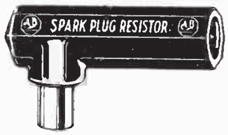

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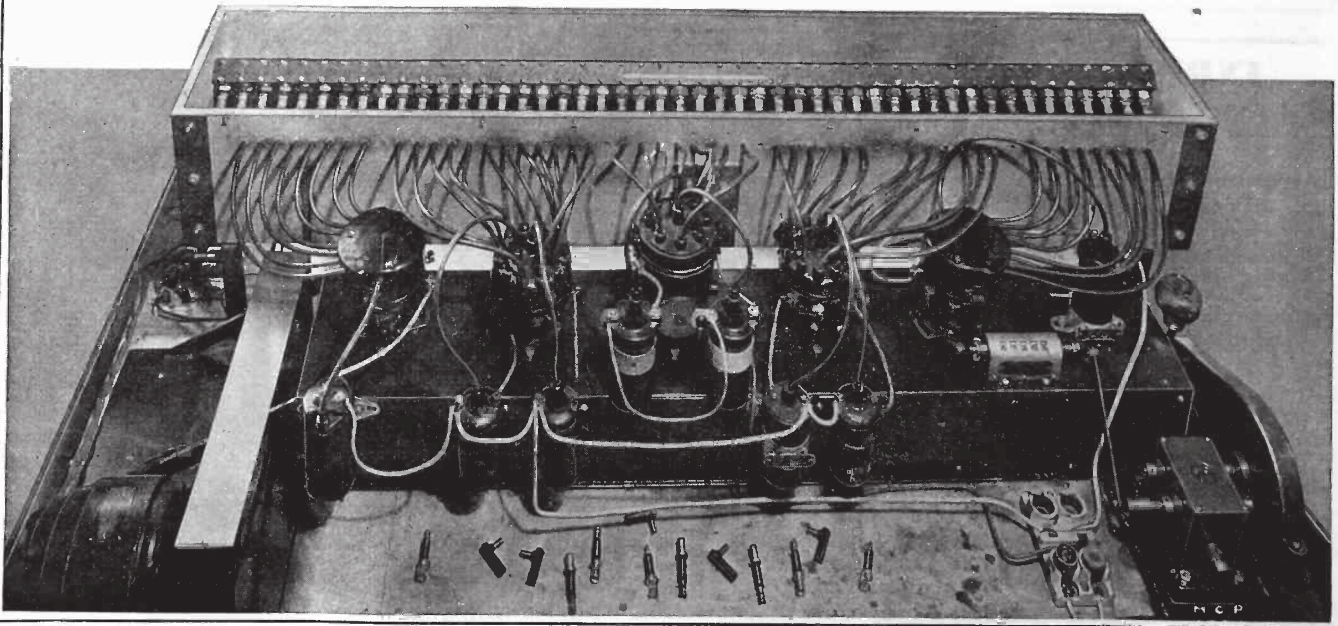

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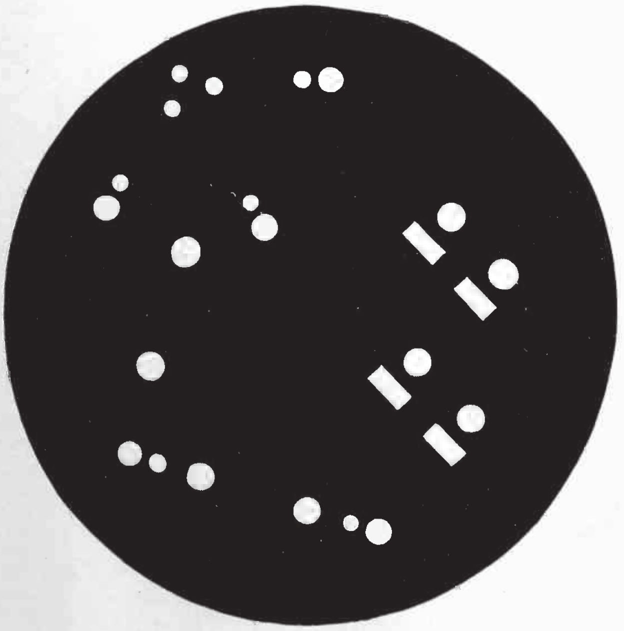

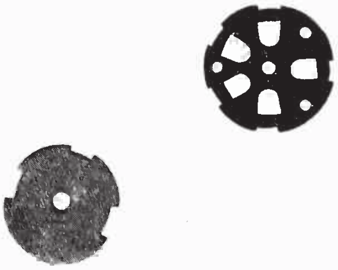

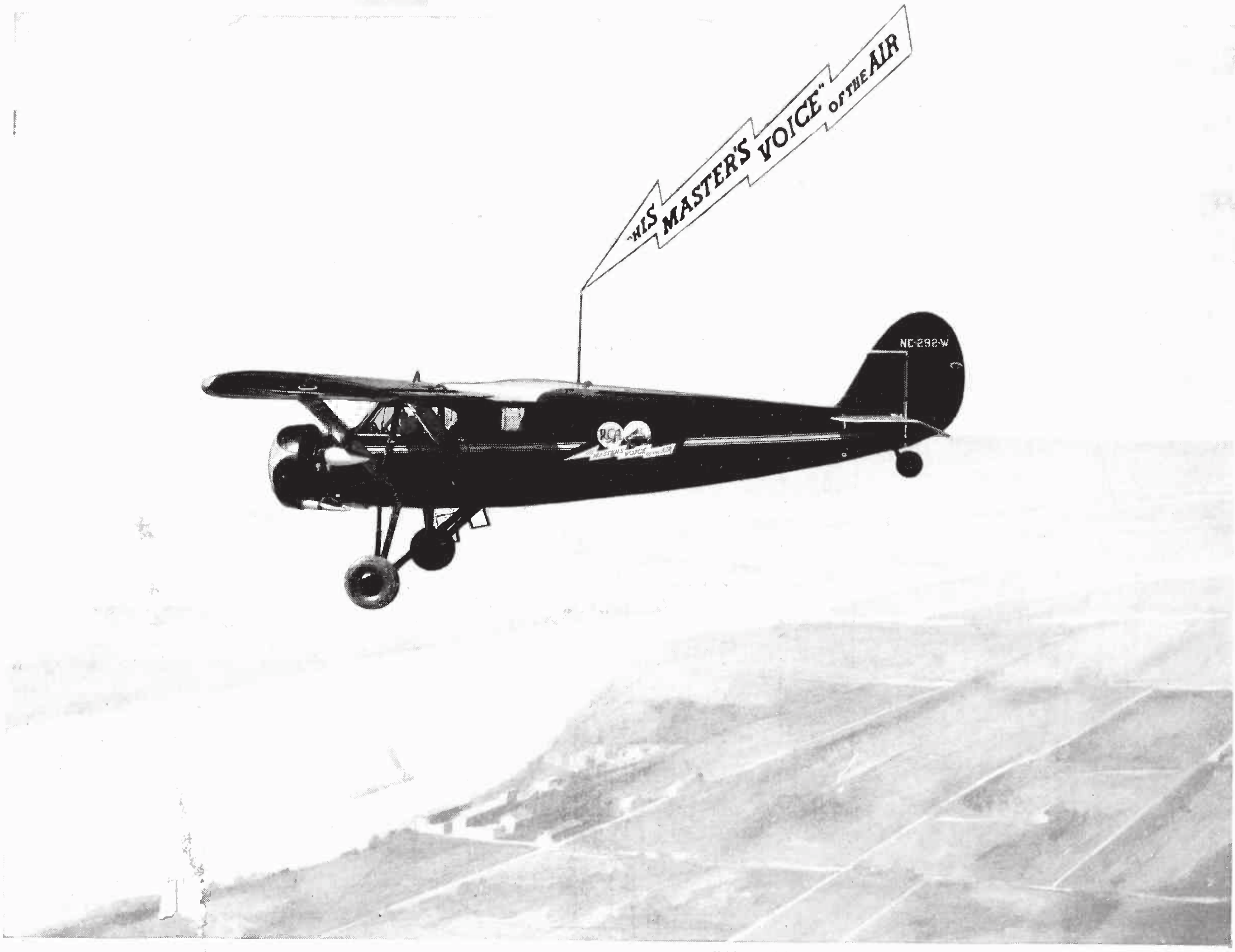

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◆

Photocells in industry
Lists of uses

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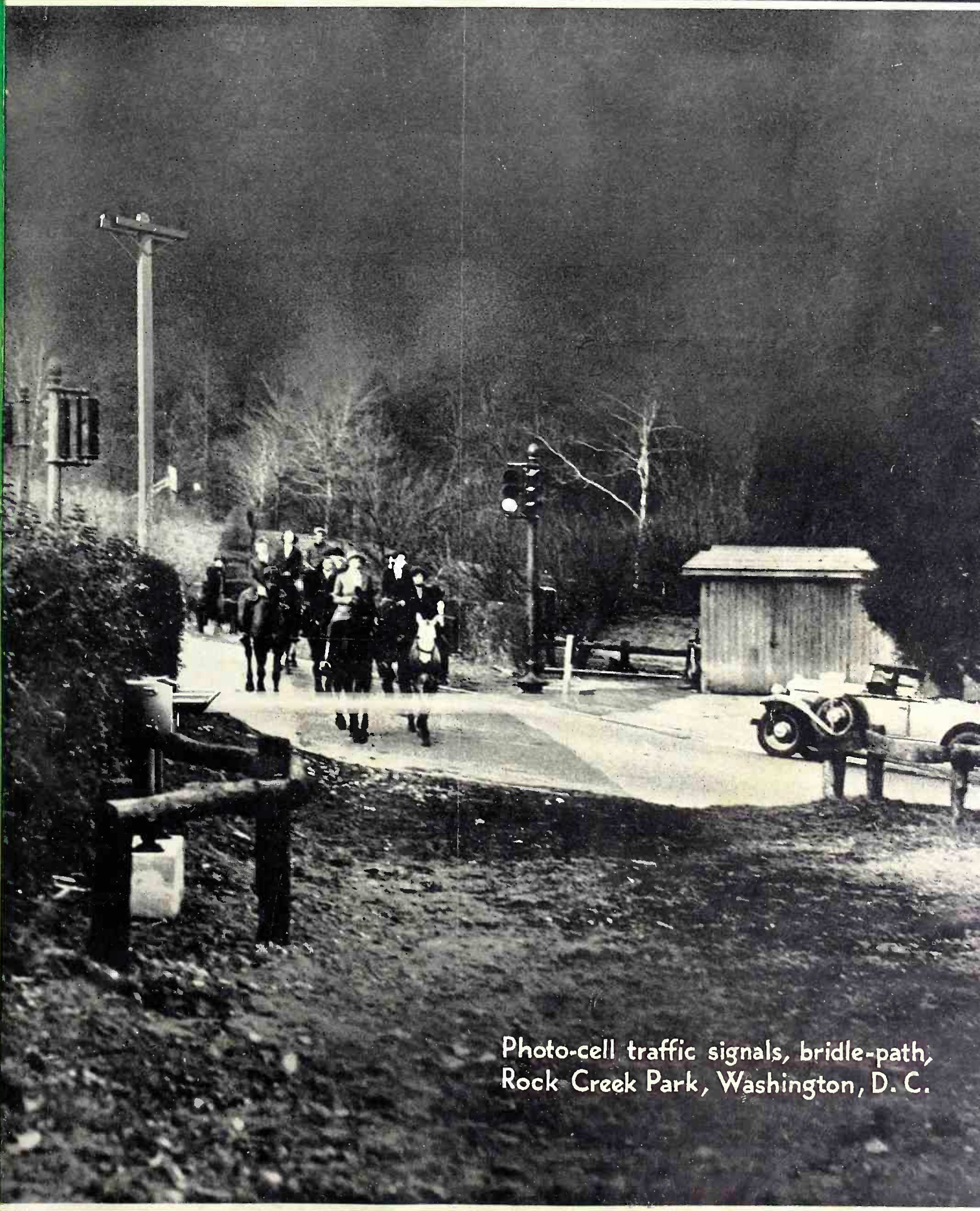

Photo-cell traffic signals, bridle-path, Rock Creek Park, Washington, D. C.

McGRAW-HILL PUBLISHING COMPANY, INC.

Price 35 Cents

OCTOBER, 1933

TRY *PHOTRONIC (PHOTO-ELECTRIC) CONTROL

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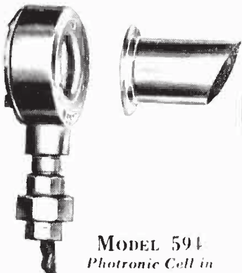
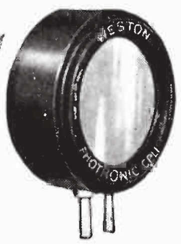
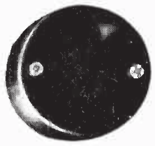
WESTON PHOTRONIC EQUIPMENT



Model 591
Photronic Cell in metal housing and visor



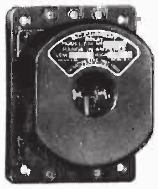
Model 594
Photronic Cell in Bakelite case



D68690
100 *Watt Auxiliary Relay*

Model 613
Time Delay Relay

Model 30
Sensitive Relay



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For those manufacturers who prefer to do their own experimenting, Weston now supplies an inexpensive and practical means for them to determine the applications of PHOTRONIC Control for mechanical equipment, mechanical operations, and processes of various kinds.

A complete and inexpensive Weston PHOTRONIC Control Kit now is available—containing all equipment and diagrams necessary to start immediate experiments with this efficient and economical method of control.

The equipment included in this kit can be used as a smoke detector, burglar alarm, turbidity detector, door opener, counter for all classes of service, safety device on machines, etc., etc. These are but a few of the present industrial applications for the Weston PHOTRONIC Cell, which has the peculiar faculty of transforming light energy directly into useful electrical energy.

There is hardly a plant or a process but what can be benefitted by the use of PHOTRONIC Control. It undoubtedly has some application in your plant. Investigate its possibilities today. This new kit simplifies the job. Write for bulletin C2 which gives complete data . . . Weston Electrical Instrument Corporation, 618 Frelinghuysen Avenue, Newark, New Jersey.

*Photronic—*a registered trademark designating the photoelectric cells and photoelectric devices manufactured exclusively by the Weston Electrical Instrument Corporation.*

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Instruments

ELECTRONICS, October, 1933. Vol. 6, No. 10. Published monthly, price 35c. a copy. Subscription rates—United States, Mexico and Central and South American countries, $3.00 a year. Canada, including duty, $3.50 a year. All other countries, $4.00 a year or 20 shillings. Entered as second class matter April 4, 1930, at Post Office at New York, N. Y., under the Act of March 3rd, 1879. Printed in U. S. A. Cable address "McGrawhill, New York." Member of A.B.P. Member of A.B.C. Copyright 1933 by McGraw-Hill Publishing Co., Inc., 330 West 42d Street, New York, N. Y.

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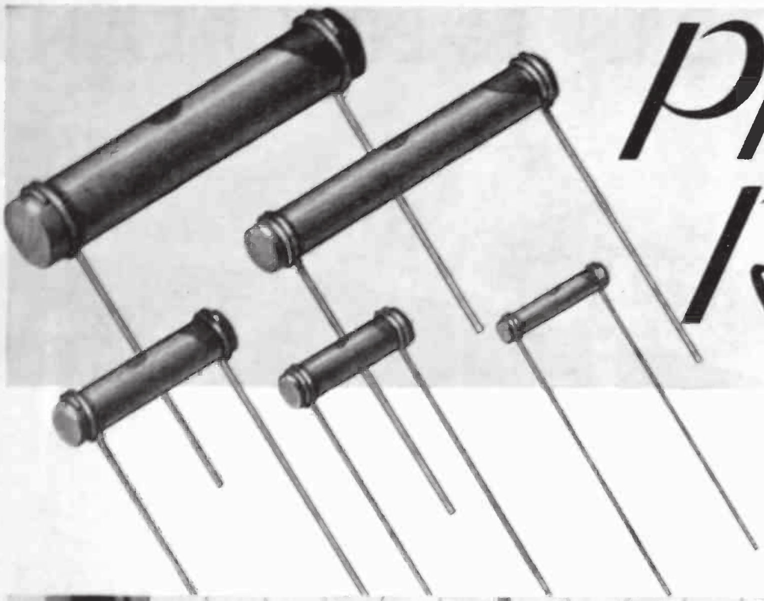
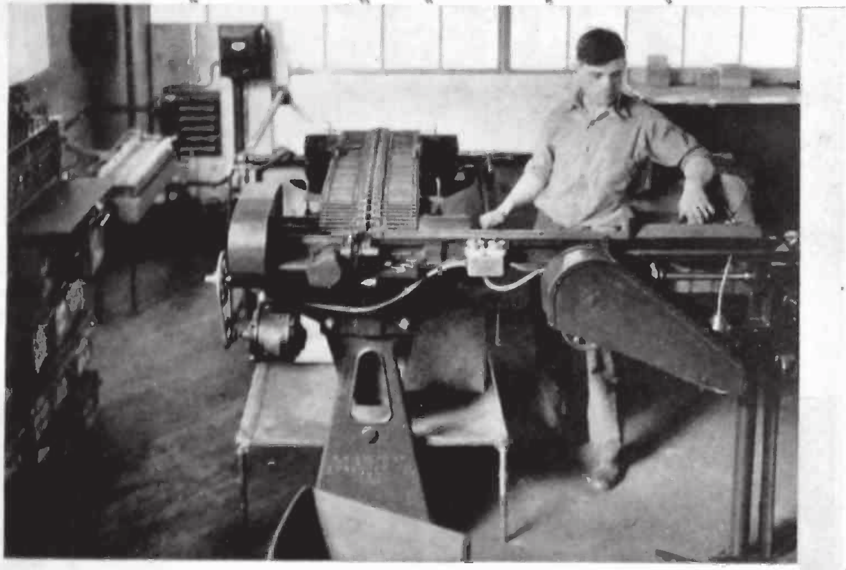


PRECISION RATINGS



Left. The electrically controlled and operated machine which automatically sorts values within predetermined percentages of tolerance limits.

Below. Trained operators complete the final stage in manufacture by a check test.

Throughout the various stages involved in the manufacture of ERIE RESISTORS every possible precaution is taken to insure precision ratings.

Automatic machinery designed especially for our use, is employed throughout each of the many steps necessary to produce a dependable resistor. After completion, the work of the various machines is given a final check test by trained operators.

The thoroughness which characterizes ERIE RESISTOR manufacturing methods is reflected in a finished product which measures up to the most rigid requirements.

When you specify ERIE RESISTORS for your production you may be certain that you are giving your eventual customer the very best the market affords.

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Erie Resistor Corporation
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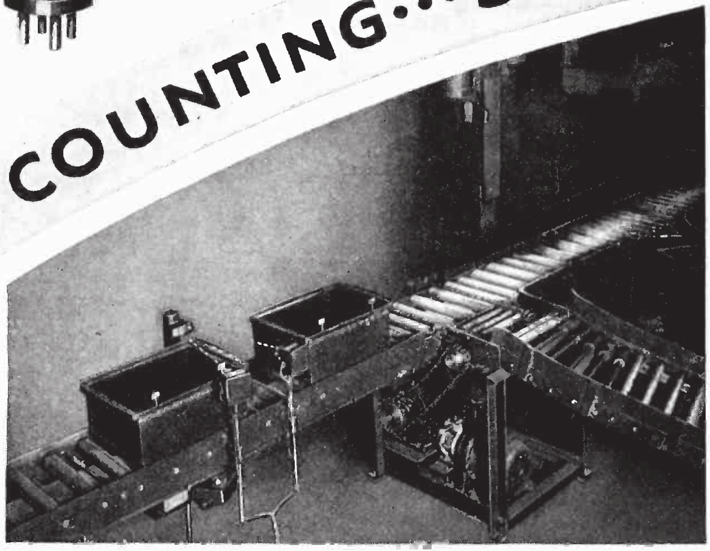
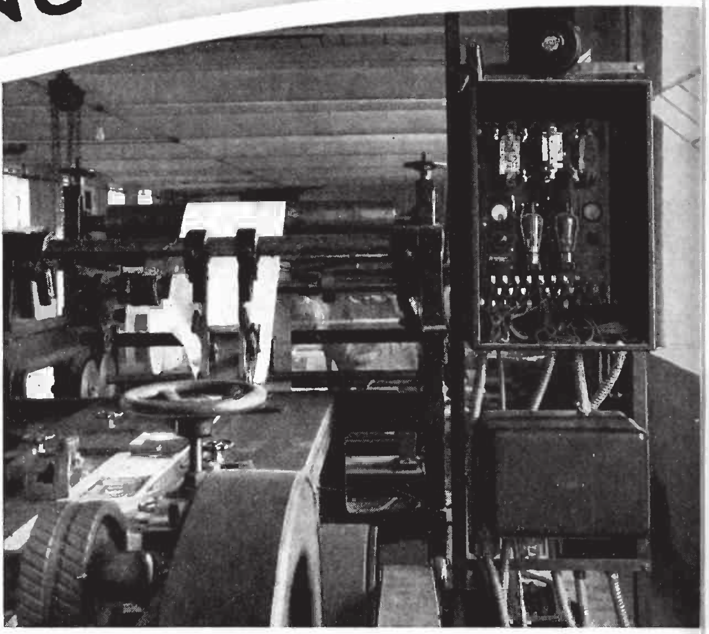
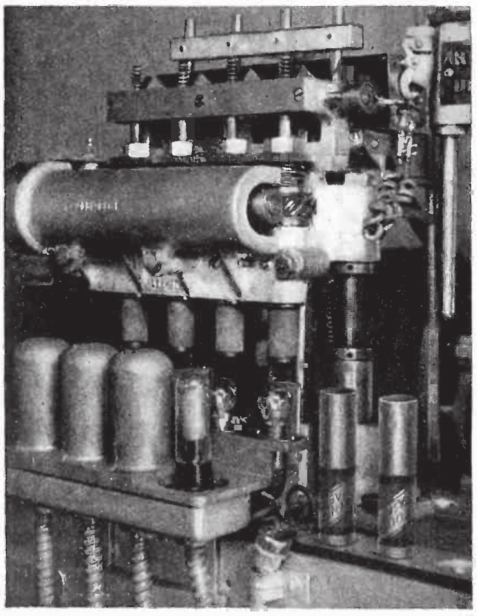
COUNTING... SORTING... GRADING...



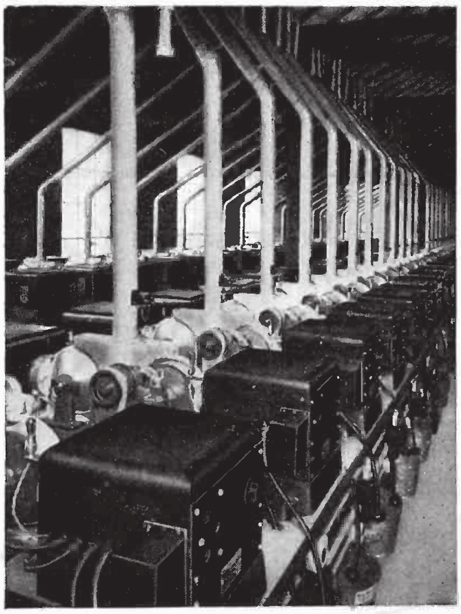
G-E photoelectric equipment acts as "dispatcher" on this conveyor line, switching preselected "cargoes" in the boxes from the continuous stream on the main line to the spur line. The application provides positive automatic control



G-E electron-tube control that includes both "electric eyes" and Thyratron tubes, is used on this bag-making machine for maintaining register when cutting the printed paper. Cumulative errors are avoided



In this tooth-paste-tube filling machine, G-E photoelectric relays stand guard to see that the tubes are rotated into position for crimping, thus reducing spoilage of material and containers, as well as increasing production



Here a battery of "electric eyes" in G-E photoelectric relays inspects beans. Only perfect beans will pass this critical inspection. Installations like this improve products and reduce costs

A G-E photoelectric relay was put to work counting sheets of mica passing through this machine, and registering an exact count before the eyes of the operator. The saving in time and material more than justified the cost of the installation

GENERAL ELECTRIC

THAT "ELECTRIC EYES" CAN DO BETTER

REGULATING...INSPECTING...INDICATING...CONTROLLING

ILLUSTRATED here are just a few of the many difficult jobs perfectly handled by "electric eyes" in G-E photoelectric control. Products are improved, production costs are lowered—50% in one case and many times the cost of the equipment in another—spoilage is decreased, and accuracy assured, all by the addition of simple equipment that is easily installed.

Ask a General Electric representative to show you a sample of our photoelectric control, and to explain how a simple unit can reduce waste motion. The coupon is for your convenience; clipped and mailed, it is an investment in efficiency information.

The CR7505-K1 is the latest addition to the family of G-E photoelectric relays, all of which have been carefully designed to meet your needs. The CR7505-K1 is compact, inexpensive, and easily installed.

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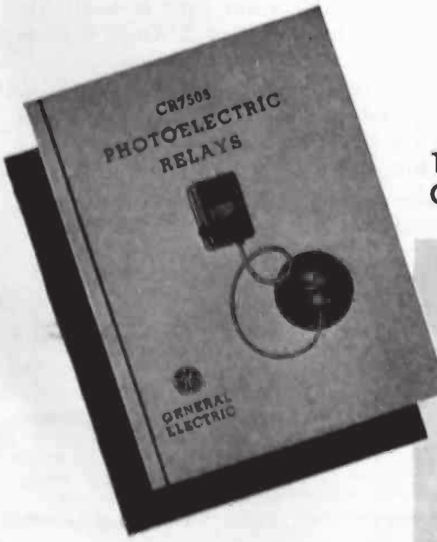

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Address the nearest G-E Office, or General Electric, Dept. 6-201, Schenectady, New York.

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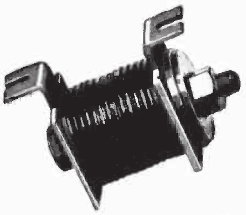
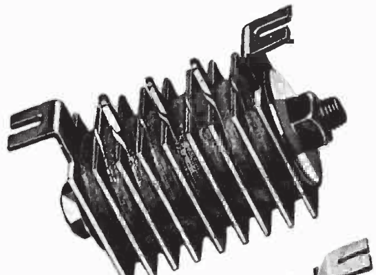
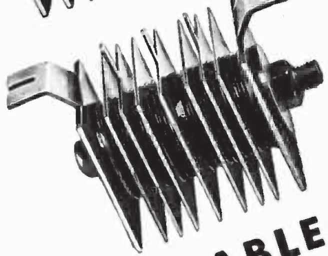
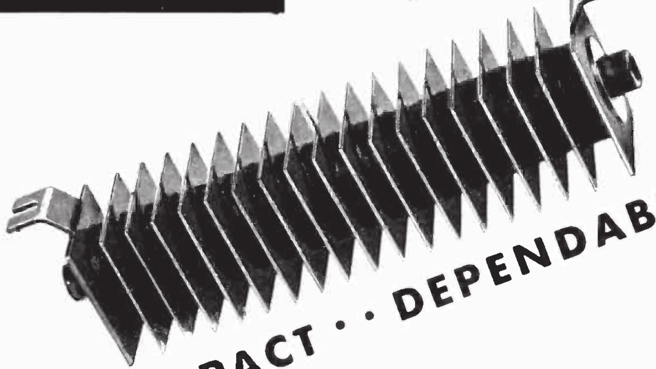
MALLORY ELKON

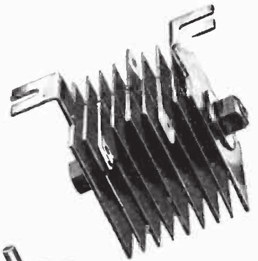
DRY DISC RECTIFIERS

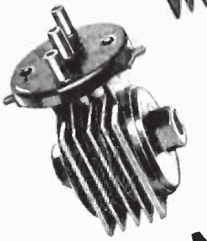












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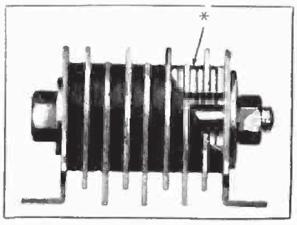

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In connection with Mallory-Elkon high capacity dry electrolytic Condensers, the Mallory-Elkon Rectifier unit is available as an A Power in capacities of the order of 2 Amp. 6 volts to 6 Amp. 6 volts.

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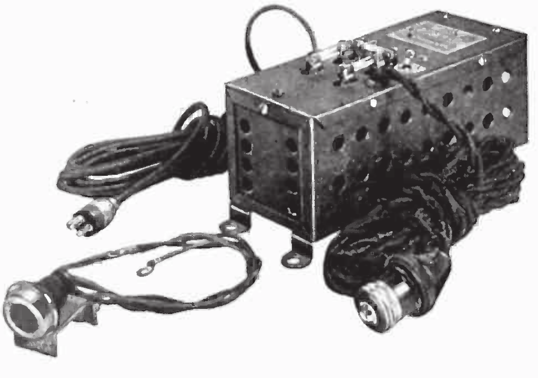
Let Mallory-Elkon engineers assist you in the solution of problems involving the use of rectifiers.

Mallory-Elkon Battery Charger

Available in standard capacities from 2 Amp. 6 volts to 12 Amp. 12 volts. Other capacities available upon request.



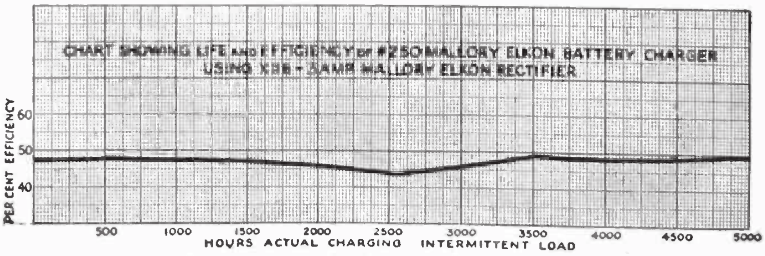


CHART SHOWING LIFE AND EFFICIENCY OF #250 MALLORY ELKON BATTERY CHARGER
USING X[illegible] - [illegible]AMP MALLORY ELKON RECTIFIER
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1500
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2500
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3500
4000
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PARTS TO PERFECT THE WHOLE

in RADIO, ELECTRICAL, AUTOMOTIVE AND INDUSTRIAL FIELD

electronics

O. H. CALDWELL
Editor
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McGRAW-HILL PUBLISHING COMPANY, INC.

New York, October, 1933

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geophysics

The plight of the radio engineer

NO CONDITION facing the radio industry is more important to the present and future prosperity of the art, than the unemployment situation in which the average radio engineer finds himself.

If he has a job at all, the technical radio man is likely to have imposed on him low wages, long hours, Saturday and Sunday overtime, and insecurity of employment. In certain plants, good men are temporarily taken on at bare subsistence wages, drained of their ideas, and then in a few weeks turned out on the street again—the process to be repeated with a new batch of "laboratory fodder."

IT IS clear that such a policy cannot build for stability or real progress of the art. New products and services which the public buys, come from engineering minds. It is poor economy to kill off the producers of the golden eggs.

The Institute of Radio Engineers has recognized this unsound employment condition by the appointment of a special committee to study the problem, with no less a chairman than the president of the Institute, Dr. L. M. Hull himself. This committee can set out the facts and propose solutions. It early developed that the NRA Codes had no place to take up the radio engineers' problems, but there is still hope that out of the improved business conditions resulting from NRA, the radio engineer may benefit.

Meanwhile there is much talk about organizing the engineers for self-protection.

WE WOULD be slow in advising intellectual laborers like radio engineers to attempt to organize on an out-and-out labor-union basis. Yet there are those who feel this is the only way to amelioration of the radio engineers' present plight.

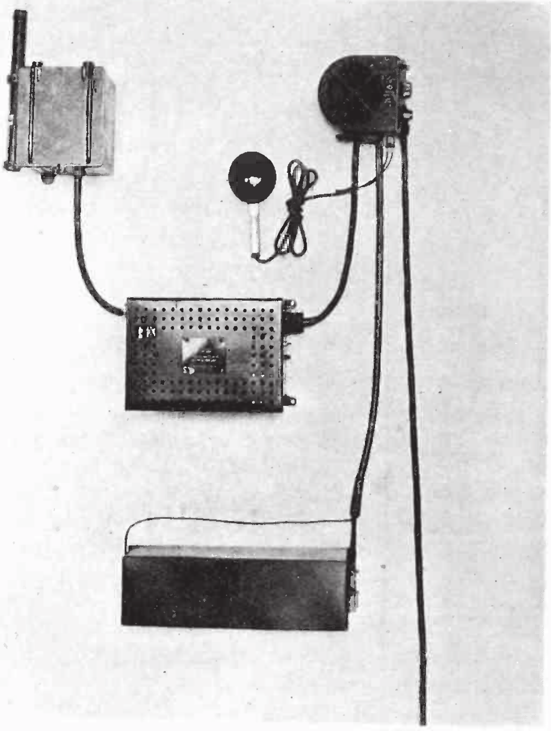
ULTRA SHORT WAVES—

Between 10 meters and 5 meters there are 1000 channels three times as wide as existing broadcast channels. These bands are ideal for local services

THE visit of Senatore Marconi to this country, and his optimistic reports of his successes in transmitting intelligence beyond the theoretical horizon, on very short waves, have focussed attention again on this vast region below 10 meters, perhaps even below one meter, which is being rapidly explored and exploited. From all appearances history is to be repeated; wavelengths once thought useless are suddenly found to be of great importance; soon the scramble to stake claims in this new goldfield will be on.

Tubes and circuits for generating power below 10 meters have not been available generally until recently. Receivers did not function as well there as on the longer waves; but the introduction of new forms of oscillators, the dome-shaped amplifiers and still more recently the brilliant work of B. J. Thompson (*Electronics,* August, 1933, p. 214) seem to have overcome these difficulties. Transmitters and receivers of conventional circuits now operate at wavelengths of one meter and lower.

In the region between 10 meters and 1 meter, services are already being found. For several years the broadcasting chains have used portable equipment for remote pick-ups, using wavelengths of the order of 5 meters. Several installations of two-way police communication systems have been put in operation using waves much below 10 meters. So simple are these equipments that they cost much less to install and keep up than similar, or even less useful, systems on frequencies now assigned to police use. There are ten channels now available for police networks; but eighty odd stations already are on the air. And there are more than 250 cities with population greater than 25,000—and each has a right to ask for a wavelength and permission to protect itself with police radio communication. From any one of these cities a dozen other police systems can be heard after nightfall—so great is the interference that what was once "interesting listening" to the novice now becomes an uncomfortable babel of bells, whistles, gongs, buzzes and "that is all."



Police car transmitter and receiver as used in Bayonne, N. J., operated on 34.6 Mc. and affording two-way communication with headquarters and other cruisers

Compact one-pound transmitter built by Sergeant Milton A. Sewell of the Signal Corps for sending dots and dashes from meteorological balloon to give air conditions aloft

Just as in pre-200-meter days there are technical bugaboos. One is the horizon beyond which very short, optical-like, waves are not supposed to go. There are two answers—one is that there are many conceivable uses for radio where the communication need not go beyond the horizon. And secondly, Marconi and others

AND NEW MARKETS

An additional 8000 channels exist between 5 meters and 1 meter—each 30 kc wide, free from static, fading and interference by distant stations

have demonstrated that horizon or no horizon, messages put into a transmitter get to the receiver far beyond the theoretical limit.

"It is dangerous to put limits on wireless," said Mr. Marconi, recalling the famous case of thirty years ago when all scientific opinion agreed that radio waves could not go beyond the horizon. In his most recently reported work he has outdistanced the horizon by a mere nine times! It is indeed dangerous to put limits to wireless.

At a press conference with Marconi on the day he landed at New York, Mr. Sarnoff raised the question if the day might not come when personal communicating systems would be developed so that any two persons in a given locality could communicate with each other at will by means of their own portable apparatus. Mr. Marconi refused to be drawn into a discussion of this dream—but he did not refute the fact that there are sufficient channels in this part of the spectrum for the many millions of the population of a city like New York to have individual calling waves for personal communication.

At the present time frequencies above 30 megacycles are not assigned by the Federal Radio Commission for services other than "experimental." In February of this year the Commission publicly stated that "the very high frequencies offer a possible solution of the shortage of frequencies (for police systems) but these bands are still in the developmental stage and will not be opened for any commercial use until more specific information with regard to the possibilities has been obtained."

But in Bayonne, N. J., a system is in operation by which police cars may not only communicate with headquarters and get orders from the man on the desk, but can converse with each other as they may be hurrying to a given location. Much time is saved by this two-way system. Tests have been made in Boston on a similar system; equipment of the same nature has been placed in a plane owned by the Conservation Department of the State of New York. At an altitude of 6000 feet it was possible to carry on successful communication at a distance of 110 miles.

These tests are not on the so-called ultra high frequencies, that is, waves below one meter in length. But the intermediate region will probably become congested before the frontier is pushed vigorously into the nether regions. In the meantime the researchers are working on tubes and circuits which will enable use to be made of centimeter waves when the use is found.

Such wavelengths will permit the design of extremely small receivers and transmitters. The trend is in this direction even on the much longer waves used by broadcasters, as proponents of high tone fidelity have noted. One of the features of the Fall models is the "vest pocket" set illustrated here. The same elements of design which made such a compact receiver possible are being employed to make receivers for policemen to wear under their coats, extremely compact and light compared with the older art.

"There is a great vista opening up in the micro-ray region. The tiny waves are not limited to optical distances and I stake my reputation on it—micro waves are not affected by static"
—Guglielmo Marconi

Manufacturers already actively pushing investigation and practical application into these lower wavelength regions are Westinghouse (Chicopee Falls), Hygrade Sylvania (Clifton Electronics Division), Radio Corporation, Radio Engineering laboratories, and the Bell Telephone Laboratories. Of course, the Army Signal Corps and Navy engineers are busy investigating the possibilities of the frequencies above 30 megacycles for their own special needs.

Extremely small receivers are available even on broadcast waves where a large band must be tuned over. This new Kadette is 2 in. by 4 in. by 6 in. in size and has two tubes

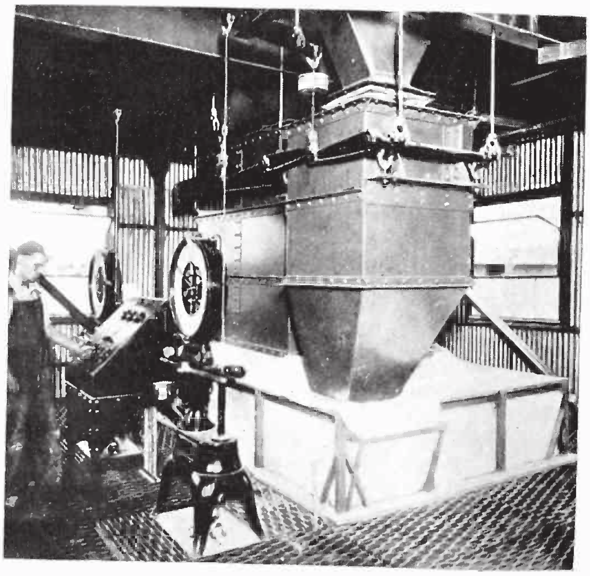
PHOTOELECTRIC CONTROL

Applications expand rapidly in number and in diversity of use

ILLUMINATION CONTROL IN OFFICES

When daylight fades, the photocell switch on the wall at the left automatically turns on the lights. And it never forgets to turn them off again, if they are not needed

AUTOMATIC BATCHING OF CEMENT



In the Brooklyn "ready-mix concrete" plant the constituents are weighed, and proper amounts automatically delivered, as scale pointer intercepts photocell

IT seems to be the history of all new inventions and innovations, that after the basic idea or method is completed, there is still a long period of lag or delay before the application of the new principle gets underway in any volume. This was the history of the steamboat, telegraph, telephone, airplane and radio,—where in each case, years elapsed between the original application, and large-scale commercial development.

The photoelectric cell has been going through an intermediate period of this kind, during recent years, when its slow development has been a matter of keen disappointment to its enthusiastic promoters. The photo-sensitive element and its relay have been ready a long time, but probably because few persons knew of the possibilities it offered in the solution of their own particular problems, the numbers of uses have been relatively limited.

But now there is evidence on every hand that photocell applications are increasing rapidly, both in diversity and in number. Installations are reaching out into new fields, and in industrial plants, power houses, machine shops, scientific laboratories, stores, offices and homes, use is being made of this electronic robot control.

On following pages the long list of uses of photo-cell units, bears witness to the rapid progress that has been made since a similar list was compiled by *Electronics* two years ago. Naturally this list, long as it is, is necessarily incomplete, for there undoubtedly are scores of other uses that have not come to light. Plant managers who find some new adaptation of the photoelectric cell too often shroud their discovery and use in great secrecy, and one of the principal difficulties the *Electronics* staff has had is in getting photocell users and enthusiasts to let the outside world know what they are doing. The suppliers of the photocell equipment often do not learn what use is being made of the apparatus, and if they do learn, they are obligated to keep the confidence of the customer. This attitude of secrecy, and effort to secure some advantage of exclusive use, holds back the wider extension of photocell apparatus. Eventually, of course, this will be overcome, and uses of photocells will become universal, and universally known.

An important extension of the application of photocells made during the past year or two, has been the incorporation of photoelectric units into the apparatus and machines made by other manufacturers. Builders of mechanical conveyors now supply built-in photocell units for counting and for dispatching of conveyor loads according to pre-set schedules. Makers of dyeing equipment make use of photocells to control the handling and processing of the materials going through their machines. The automatic-scale people have been quick to see the advantages of photoelectric linkage between the beam pointer and any mechanical operation to be performed, since the intercepting of a ray of light imposes no load whatever on the accurate reading of the scale. The makers of automatic door-openers, now find the photocell the best possible means of control. Elevator makers have found the safety value of photocell protec-

WIDENS IN INDUSTRY

Manufacturers of machines now provide photoelectric features

tion of their elevator thresholds, against improper starting of their cars, and now build photocells into their elevator equipment as integeral parts, for safety-doors and for car-leveling. Meanwhile a host of scientific instruments have had their usefulness or sensitiveness or accuracy extended, by utilizing photocells which now become a part of the apparatus.

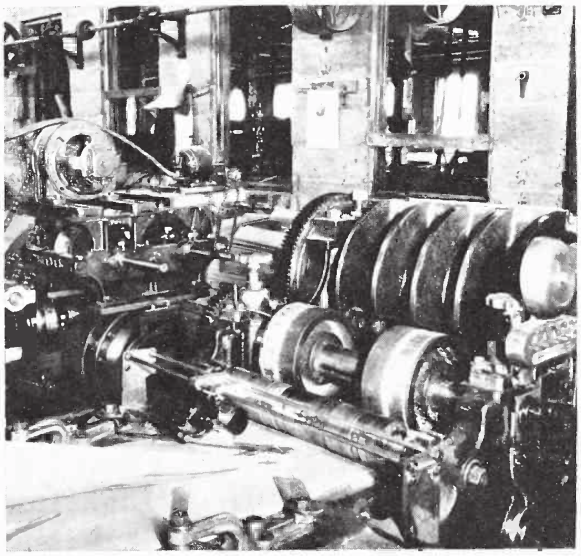
The only shadow that lingers over photoelectric installations is that of proper and adequate individual design and construction, where single or initial jobs are concerned. The engineer who installs a photocell unit is not finished with his job if he merely makes it work. He must make sure that its performance fits in with all the everyday requirements and conditions surrounding its use. The installing engineer must approach the problem from the standpoint of the ultimate user, and find out what is going to happen under practical conditions.

Take the installation of such a simple job as a photocell drinking fountain, to enable a valve to be controlled and the water turned on when one lowers his head over the spout. In one case, we know about, the photocell man came and arranged the circuit all right. But in this job, as he left it, any failure of the lamp or photocell circuit left the valve irrevocably closed and a hundred office workers without water. Next it was discovered that the tubes were mounted on a swinging door, which the cleaning women could bang closed, wrecking the tubes. The automobile-lamp socket also softened in the continuous heat, letting the lamp contacts slide open. The lamp and photocell supports of light metal, proved too weak; people leaned against them, twisted them, got them out of line. For all these failures and annoyances the *photocell* had to *take the blame,* although never in months of operation did the photoelectric apparatus itself ever give any trouble. Now a pushbutton contact has been put onto the relay so that the valve can be operated at all times, a main switch has been installed controlling both lamp and amplifier panel, and the installation gives no more trouble. It is now a workaday installation, that fits the everyday office routine. Yet as the photocell man left it, because he did not look beyond his photoelectric circuits, it was a failure and a nuisance.

The lesson here, is, that the man who installs photocell or electronic equipment must, before leaving it, see that it meets the everyday conditions to which it will be exposed.

But now photocell applications are going ahead on a constantly wider front. New cells are being developed, and new facilities are being provided for special uses. The characteristics of cells are better understood, and engineers are learning that there is a cell for each purpose, and that the right unit can be depended upon to bring results. The production of photocells is climbing rapidly, while the number of concerns allied in one way or other with photoelectric control continues to expand. A new industry is developing which will bring new facilities of control to machines, replacing the routine action of the human eye and brain, and freeing human faculties for more constructive effort.

DIRECTS REGISTER OF CUTTING KNIFE



In this cement-bag-making machine at Jaite, Ohio, a photocell controls the register of the cutting knife, so as to line up with the printing

SAFETY-RAY ELEVATORS AT RADIO CITY

If a belated passenger steps across the threshold of this elevator, two safety-ray beams are intercepted and reopen the door. There are 58 elevators so equipped at Radio City, New York

A LIST OF PHOTO-

▶ This list of uses of photoelectric-control applications has been collected and compiled by *Electronics* from a large number of sources. Most of the uses named are actual operating installations. In a few cases, applications listed are potential or experimental. They are included here, however, since the chief value of a listing of this kind, lies in its stimulation of invention and the application of photo-cells to other problems.

✦ ✦ ✦

Industrial

Reversing rolls in steel mill
Removal of soaking-pit covers
Control of cut-off saws
Furnace temperature control
Operating limit switches for motor travel
Controlling thickness of sinter beds
Smoke indicators in smoke stacks
Combustion indicators (showing "haze-point")
Detecting fine cracks in polished surfaces
Opening doors for hand trucks, motor trucks, etc.
Automatic operation of mine ventilating doors
Operating valves, switches
Warning signals on rolls in tire factory
Remote control of machines
Safety protection of machines
Detection of flaws in products
Alarm for water-hardness
Analysis of card records
Turning threads on pipe and conduit
Fire-alarms, smoke alarms
Paper-making machine—paper break detection
Piling bags by conveyor
Conveyors in heat-treating furnaces
Operation of rod shears, merchant-mill shears
Pressure application in chain welding
Feed to rubber-cutter table
Pre-selective conveyor dispatching system
Automatic weighing of batches
Registering printing, folding, cut-offs, etc.
Synchronizing conveyors
Chemical process control
Leveling elevators
Inspect storage-battery caps for vent holes
Sorting electrical resistances
Flagging tote pans on conveyor at selected station
Control of pulp in beater in paper mill
Controlling thickness of enamel on wires
Rejection of non-sharp razor blades

Food and Chemical Processes

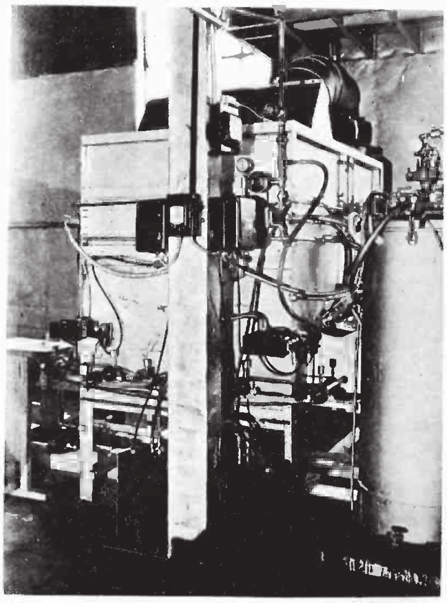
Controlling levels of contents of tanks and bins
Drinking fountain control
Turbidity control in water supply
Cold-room door operation
Control of motors from indicating meters
Automatic control of heat-treating
Opening doors for animals (dairy, stables, etc.)
Tooth-paste filling machine
Bottle fillers
Metal-tube inspection
Control of coffee roasters
Candling eggs
Moth control in orchards
Synchronizing of two conveyors
Sorting raisins at 1,000 per minute
Sorting lemons, beans, etc.
Eliminating green peaches from cannery stock
Sorting cigars
Testing oil
Control of acidity, alkalinity
Sludge level indicator for sewage-disposal plant

Light Control

School-room lighting
Shop and factory lighting
Electric signs

✦

A PHOTOCELL LUMBER PAINTER



This machine sprays paint as lumber passes through its spray chamber. But photocells control the spray valves, so that only when a piece of lumber is in the machine does the paint-spray operate

Flood lighting and decorative effects
Store lighting
Office lighting
Street lighting circuits
Air ports, aviation beacons
Light-houses, range lights, markers, etc.
Store and window lights, turned on at approach of passers-by or patrolman
Parking lights on autos, automatically lighted at dusk
Riding lights on moored vessels, automatically lighted
Signs along roadway, lighted on approach of car headlights
Photographic printing and enlarging

Counting, Measuring

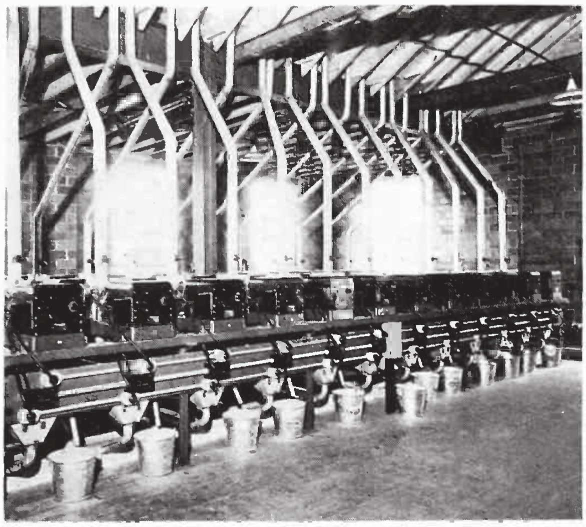
Production lines (motors, automobiles, radios, refrigerators, etc.)
Traffic in tunnels, on bridges, etc.
People passing, or entering (theaters, etc.)
Animals, livestock, etc. in stock-yard pens
Recording beats of master clock
Printing and engraving
Tabulating statistics, quantities
Measuring lamp candlepower
Timing races
Integrating irregular areas by measuring light transmitted
Astronomical measurements
Color measurement
Turbidity measurement
Projectile velocities
Calipering steel balls
Control of sprays in lumber painting machine
Boiler-guage level alarms
Automatic sheet-catchers in rolling mills
Counting of printed items on cards, totalizing and analyzing
Life tests of floor material in public places
Automatic inspection of razor blades
Counting ingress and egress of honey-bees from hive
Weighing machines

Visual Reproduction

"Facsimile" transmission of photographs, maps, newspapers, etc.
Television transmission
Half-tone and line-cut production
Three-color plate engravings
Enabling blind to read ordinary print
Automatic curtains framing movie screen
Photography of wild-animal life
Automatic photographing of sneak-thieves, burglars, etc.

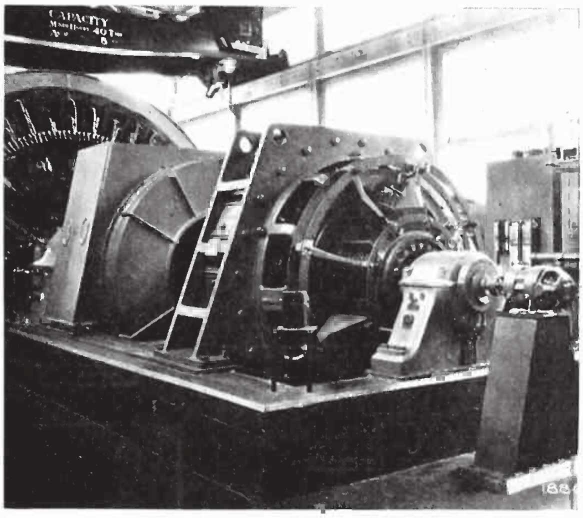
CELL APPLICATIONS

BEAN-SORTING MACHINES



Beans by the carload can be sorted rapidly and cheaply by these twenty-four photoelectric thyratron sorting machines at Lowell, Mich.

SEES FLASHOVER BEFORE IT HAPPENS



If a flashover starts on this railway motor-generator commutator, the photocell trips the circuit-breaker before damage can be done

✦ ✦ ✦

Safety Uses

- Protection of punch-presses and other dangerous machines
- Protection of elevator doors, preventing car from starting unless all passengers are clear of threshold
- Transmission of weather maps to ships at sea
- Detection of ice-bergs, ships, etc. through fog
- Safety doors in mines
- Remote control of dangerous processes
- Protection of jails, penitentiaries, etc.
- Protection of electrical machinery
- Traffic-signal operation
- Auto speeding detectors
- Street-lighting control
- Burglar and kidnapping alarms
- Talking "rogues' gallery" (sound pictures)
- Detection of dangerous gases in tunnels
- Hold-up protection, banks, etc. (closing of safety steel shutters)
- Fire alarms, smoke alarms
- Safety protection of oil-burners
- Airway beacons
- Lighthouses and marker lamps
- Sewage treatment control
- Gunfire control

Sports

- Timing horse races
- Timing athletic contests
- Foul-line for bowling alleys
- Timing of golf-club swings
- The photo-electric shooting gallery (Light-beam gun; photocell as target)

Grading

- Cigars
- Tile
- Beans, vegetables
- Detecting missing labels
- Inspecting tin-plate
- Calipering small parts
- Color comparison
- Adjusting auto headlights
- Detecting flaws in products
- Sorting checks and bills
- Matching false teeth

Traffic Applications

- Railroad signals (European)
- Street traffic lights
- Elevator leveling
- Elevator-door safety control
- Elevator safety stops
- Routing mail-bags and letters
- Counting street traffic
- Checking up bridge toll collections
- Speeding subway traffic
- Checking up theater patronage
- Detecting dangerous gas in tunnels
- Lighting air-beacons and air-fields
- Controlling wind indicators from pilot-vanes
- Detecting automobile speeding, by two photocells in roadway
- Horse-operated signals for bridle-paths (See front cover)
- Parking lights on automobiles lighted at dusk
- Head lamps dimmed at approach of another car
- Head-room alarms for tunnel and bridge approaches
- Adjoining street signs and displays controlled by traffic lights
- Swing-bridge pin-lock safety indicator
- Identifying and recording freight-car numbers
- Checking auto crank-case oil at service stations
- Adjusting illumination in vehicular tunnels
- Calling gas-station attendant when car stops
- Speedometer, using two cells focussed on terrain, getting variation from first one then second cell
- Sextant for locating sun's position obscured by clouds

Printing, Publishing, Etc.

- Automatic machine setting of type, from typewritten copy
- Half-tones made by photo-electric scanning
- Automatic control of register on web presses
- Automatic control of accurate trimming
- Accurate cutoffs for labels, bags, etc.
- Automatic stops for presses, preventing paper breaks
- Adjusting density of printing
- Counting of sheets and forms in binderies
- Control of paper thickness and moisture during manufacture
- Matching the colors of inks and papers
- Controlling uniformity of color during printing runs
- Providing permanent unfading color records
- Measuring glare and opacity of paper
- Transmitting photos by wire direct to engravings
- Safety-first devices around presses

- Detecting and correcting press vibrations
- Automatic door-openers for binderies, shipping rooms, etc.
- Automatic mailing list analysers and sorters
- Automatic light-intensity control in printing and engraving plants
- Control of paraffine-vapor spray for preventing offset
- Grading of photographic negatives in gravure process
- Bleaching-process control
- Reclaiming of "white water," control of digester, etc.

Sound Production

- Phonograph recording
- Sound-picture recording
- Sound-picture reproduction
- Light-beam transmission
- Light siren
- Photo-electric organ
- Modulation of broadcast transmission
- The "talking book"
- Talking wills
- Talking "rogue's gallery"
- Automatic merchandiser says "thank you" when purchase is made

Scientific Instruments

- Titration of chemicals
- Measuring viscosity
- Measuring density of photographic films
- Temperature control
- Testing oils
- Measuring total light flux
- Indicating wind velocity
- Color analyzers
- Color matchers
- Light-intensity meters
- Exposure meters
- Turbidity meters
- Combustion indicator
- Master-clock control of secondary clocks
- Control of circuits from indicating meters
- Indicating shaft rotation
- Meridian passage of stars
- Recording variable stars
- Guiding telescope on star
- Detecting faint spectral lines
- Measure instant of eclipse
- Measure width of eclipse path
- Measuring high rotational speeds by light producing tones
- Sighting guns for automatic firing
- Current detectors and amplifiers. Light beam reflected from galvanometer mirror falls on photo-cell

Home Possibilities

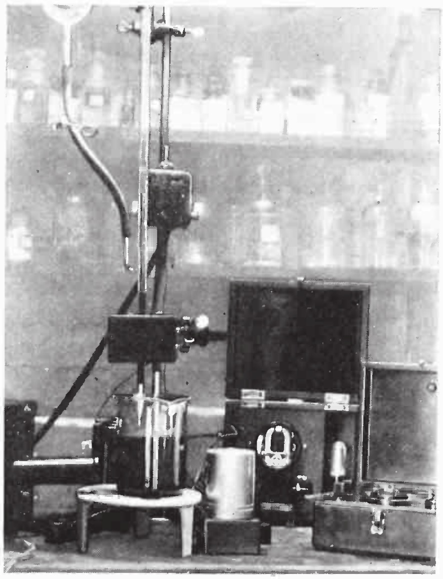
- Controlling uniform illumination in work rooms
- Monitoring oil-burner pilot flame, to operate safety valve
- Garage-door openers
- Alarms against burglars and trespassers
- Flood-lighting control
- Night-lights around house automatically turned on and off
- Automatic operation of door between dining room and kitchen
- Automatic opening of refrigerator door
- Motor shaking of furnace grates automatically cut off when bright coals pass into ash-box
- Photographic exposure meter
- Turn off radio set during objectionable programs
- Photo-cell musical instruments
- Window raising and closing mechanism
- Aids for invalids, the crippled, etc.
- Kidnapping alarms for nurseries

Electric Power Systems

- Synchronizing power circuits
- Controlling alternator frequency
- Detecting flash-overs on rotary converters
- Reporting circuit-breaker operation
- Controlling street-lighting circuits
- Safeguarding high-tension buses
- Bus flash-over protection
- Controlling isolated plant operation from predrawn chart

✦

COLOR CONTROL OF CHEMICAL PROCESSES



When the mixture in the beaker changes color, indicating the end point of the reaction, the photo-cell relay closes the valve admitting the standard solution

✦

Manufacturers of light-sensitive cells

Acousto-lite Corporation,
2908 S. Vermont Ave., Los Angeles, Calif.
Selenium and self-generating cells

Burgess Battery Company,
Freeport, Ill.
Selenium cells

Burt, R. C. Laboratories,
890 E. California St., Pasadena, Calif.
Photoelectric and selenium cells

Clark Instrument Company,
119 N. Fourth St., Camden, N. J.
Selenium cells

Central Scientific Company,
460 E. Ohio St., Chicago, Ill.
Photoelectric cells

Continental Electric Company,
St. Charles, Ill.
Photoelectric cells

DeVry, H. A. Company,
55 E. Wacker Drive, Chicago, Ill.
Photoelectric cells

Electronic Inspection Laboratories,
624 Hayden Ave., Cleveland, Ohio.
Liquid self-generating cells

General Electric Company,
Schenectady, N. Y.
Photoelectric and selenium cells

G-M Laboratories
1731 Belmont Ave., Chicago, Ill.
Photoelectric cells

Hygrade-Sylvania Corporation
Clifton, N. J.
Photoelectric cells

Intellect-a-Ray Corporation,
Singer Building, Pasadena, Calif.
Selenium cells

QST Laboratories,
6921 Natural Bridge Road, St. Louis, Mo.
Selenium cells

Pacific Research Laboratories
489 W. Washington St., Los Angeles, Calif.
Selenium cells

RCA-Radiotron Company,
Harrison, N. J.
Photoelectric cells

Rhamstine, J. T.,
500 E. Woodbridge St., Detroit, Mich.
Selenium cells

Raytheon Manufacturing Company,
Cambridge, Mass.
Photoelectric cells

Telephoto & Television Corporation,
133 W. 19th St., New York City.
Photoelectric cells

Western Electric Company,
(Graybar Electric Company, sales agents)
420 Lexington Ave., New York City.
Photoelectric cells

Westinghouse Lamp Company
Bloomfield, N. J.
Photoelectric and self-generating cells (Photox)

Weston Electrical Inst. Corp.,
Newark, N. J.
Self-generating cells (Photronic)

✦

Light-sensitive relay units

Allen-Bradley Company,
Milwaukee, Wis.

American Instrument Company,
Washington, D. C.

Burgess Battery Company,
Freeport, Ill.

Burt, R. C. Laboratories,
890 East California St., Pasadena, Calif.

H. A. DeVry Company,
55 E. Wacker Drive, Chicago, Ill.

General Electric Company,
Schenectady, N. Y.

G-M Laboratories,
1731 Belmont Ave., Chicago, Ill.

Intellect-a-Ray Corporation,
Singer Building, Pasadena, Calif.

Western Electric Company,
(Graybar Electric Company, sales agents)
420 Lexington Ave., New York City.

Westinghouse Electric & Mfg. Co.,
Newark, N. J.; East Pittsburgh, Pa.

Weston Electrical Inst. Corp.,
Newark, N. J.

J. T. Rhamstine,
500 E. Woodbridge St., Detroit, Mich.

Struthers Dunn, Inc.,
139 N. Juniper St., Philadelphia, Pa.

Suppression of auto radio noise

By GLENN H. BROWNING
and RUPERT HASKINS

*Tobe Deutschmann Corporation,
Canton, Mass.*

TO INVESTIGATE the various factors governing the noise received in auto radio sets due to the disturbance set up by the electrical system of the gas engine is all very well, but to start such an investigation with the expectancy of obtaining data which might help solve the noise problem takes a great deal of optimism. In fact, when the writers were asked about the possibilities of uncovering useful facts along that line, they were anything but encouraging. However, measurements proved conclusively that a great deal of noise emitted from the engine could be kept from getting into the radio receiver.

In any interference problem the first task is to locate and isolate the mechanisms causing the disturbance. In many cases this is the most difficult part of the task, for once the offender is located the cure is relatively simple. Not so with auto interference. It is almost self-evident that the spark plugs are the source of most of the noise, and though commutator brushes, and other equipment may contribute a small amount, this noise is quite readily taken care of. The direct method of attacking spark plug interference yielded very mediocre results. Various designs of spark plug suppressors were made up and tried as well as elaborate shielding systems. The net results were that the interference could be reduced but not eliminated by any system that was deemed practical to install.

In running a number of such tests, curves were taken showing the noise picked up on a receiving antenna as its distance was varied from the spark plugs. It would be expected that the magnitude of this radiation would fall off rapidly, but it was difficult to predict that it would fall to about 1/70 of its value in a distance of 8 feet.

The way this radiation diminished as the distance from the source to the radio pick-up is increased is shown in Fig. 1. It will be noted that the interference is practically the same on 1,400 kc. as it is on 600 kc. Thus it would appear that all the noise sent out was a "shock" in the radio receiver at the frequency it is tuned. The set used for these measurements tuned slightly broader at 1,400 kc. than it did at 600 kc. Therefore, shock excitation was less effective on the higher frequency.

The curve indicates that if the radio antenna were

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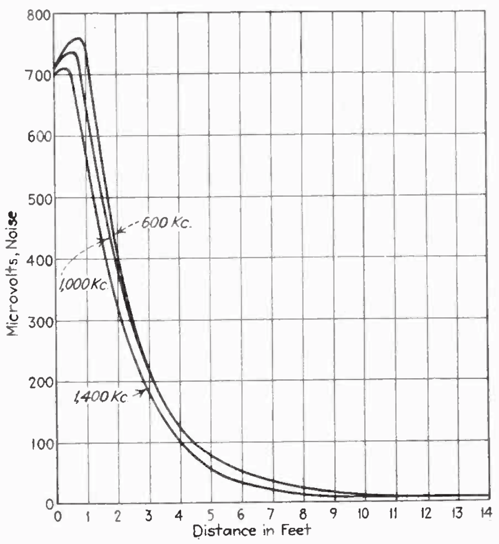


Fig. 1—Relation between radiated noise and distance from spark plugs

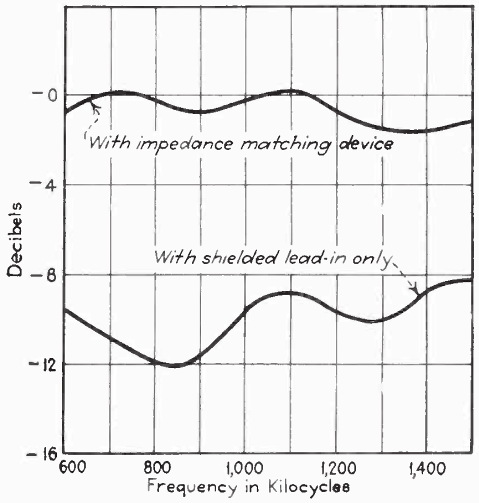


Fig. 2—Loss or gain of signal strength with or without matching transformer

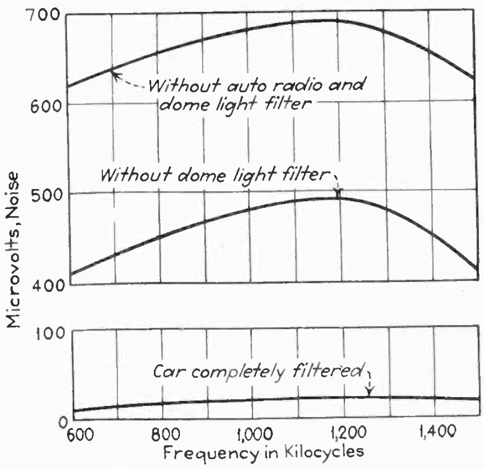
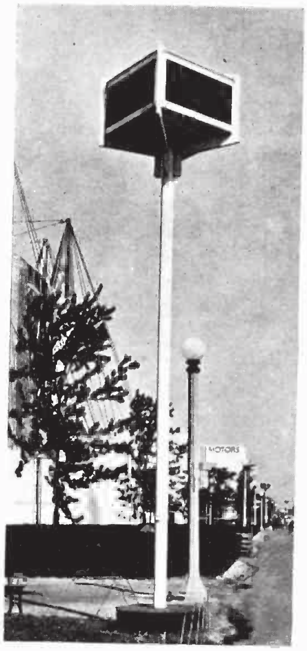
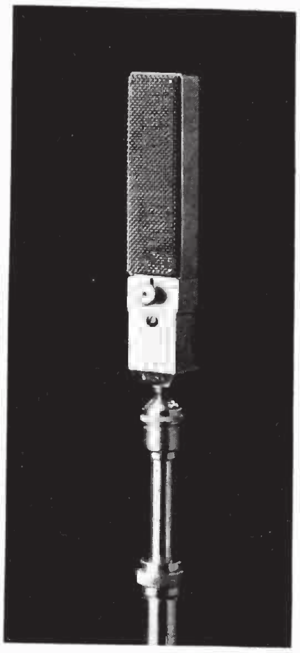


Fig. 3—Reduction of radio noises by proper filtering

Public address at The Century of Progress



One of the many outdoor loudspeaker sound outlets



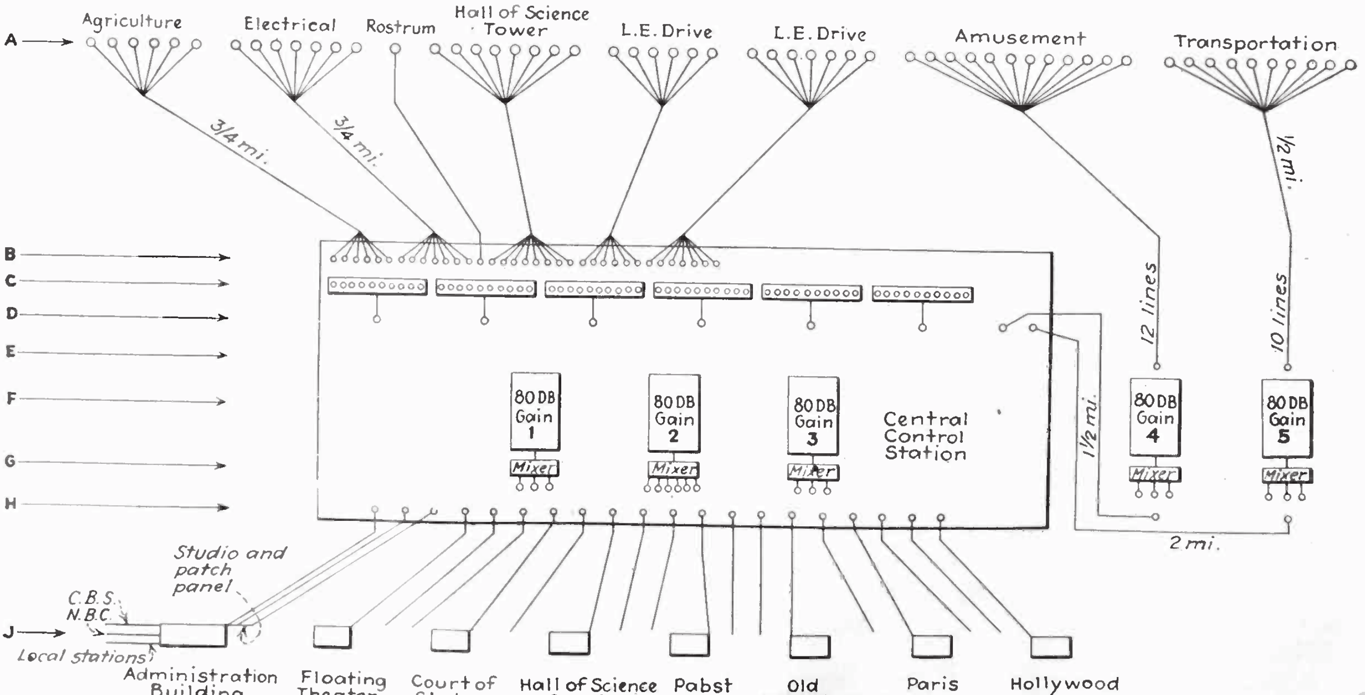
Crystal microphone — efficient input of the vast P.A. system

AMONG the many outstanding engineering feats at the A Century of Progress Exposition in Chicago, sound reproduction holds a very prominent position. More sound equipment is in use at this exposition than has ever been concentrated in one locality before. The main sound distribution system alone is the largest ever assembled anywhere in the world.

The unusual demand for coverage of an area three miles long with as many as 350,000 people in attendance has presented several very interesting engineering problem aspects of which are presented below as outlined by the Electro-Acoustic Products Company of Fort Wayne, Indiana, which developed the system.

The system is used not only for distributing information pertaining to various activities on the Exposition grounds, urgent messages to locate individuals, instructions to the Exposition Police force, which are delivered in code, but also for reproducing musical programs.

Each loudspeaker station consists of an amplifier and two loudspeakers. The construction of the towers in which this equipment is mounted is unique from both architectural and acoustical standpoints. Two heavy duty electro-dynamic sound reproducers are mounted in a box baffle on top of a 30-foot steel pole. The amplifier is located under a circular seat at the base of the pole, where it is easily accessible for tube replacements. The baffle box at the top of the tower is divided into four sections so that radiation of sound is accomplished from the back as well as the front of the cone diaphragm, thus effecting a distribution of sound over an area of 360 degrees. The top and bottom of the baffle box are sloped



Layout showing the input stations and the central control station from whence radiates sound to 57 speaker stations situated in all parts of the Century of Progress grounds. Local music, from records, is augmented by programs from pickups from five exposition points and both large national broadcasting systems downwards at an angle of 20 degrees to project the sound into the crowd.

Naturally a uniform radiation over an area of 360 degrees is not obtained at all frequencies: however, the tower is designed so that the baffle may be turned in the direction where the best coverage is desired. Sufficient radiation of extreme highs is obtained over the entire 360 degrees to transmit satisfactory quality over this area. Ten of these baffles are mounted on decorative flagpoles along the Avenue of Flags and a number of them on structures mounted on concession buildings.

Sixteen loudspeakers and eight amplifiers are installed in the Hall of Science tower, using the wall of the tower as a baffle. The speakers are mounted at a 15 degree angle to project the sound down and effect satisfactory distribution of the higher frequencies. The amplifier associated with each pair of loudspeakers is a three stage resistance and transformer coupled unit using a type 56, 59, and four 250 tubes. Two 866 rectifier tubes supply the amplifier and 30 watts to each speaker field. A gain of 75db. is available with a response flat within 3 db. from 50 to 8000 cycles. Each amplifier has a relay across the power switch and is operated through a 12 volt d-c circuit from the Central Control Station.

The gain control on each amplifier is adjusted so that the maximum level of sound desired in its area is obtained when a level of plus 2 is received from the Central Control Station.

Central control station equipment

At the South end of the Hall of Science is the Central Control Station with a room provided for announcers. The operating room is provided with a glass front through which visitors may view the amplifier racks, the patching panels and the three sets of dual turntables.

There are three input amplifier racks here with a spare amplifier used as a "standby" to be cut in immediately in case of a failure. Each rack consists of a three stage amplifier having a gain of 80 db., a main gain control, volume indicator, a three position mixer and a monitor speaker fed by its own output tube bridged across the output of the amplifier. One rack has a six position mixer.

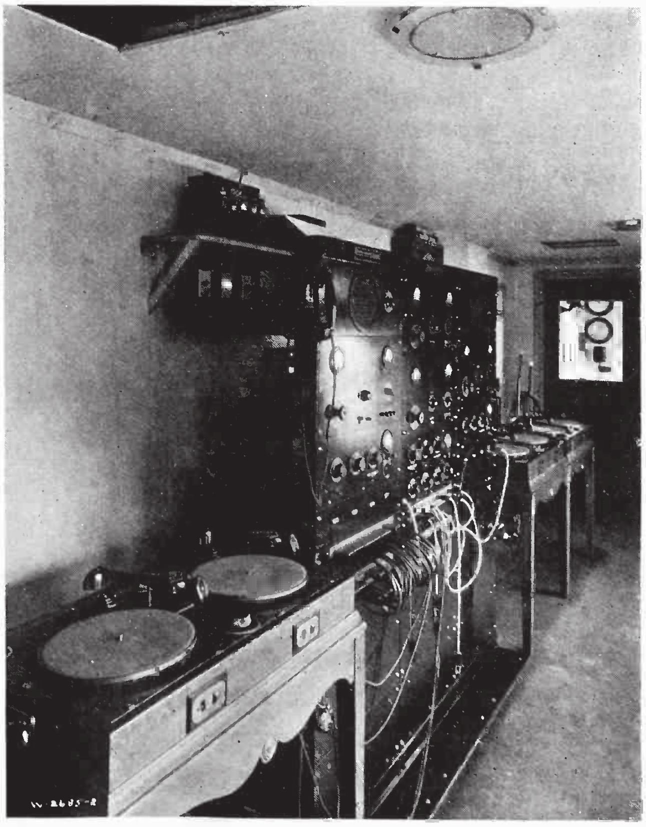
The frequency transmission characteristics of these amplifiers are not flat, the amplifiers being equalized to give plus 3 db. at 60 cycles and plus 9 db. at 7500 cycles. This equalizes the loss in the lines to the loudspeaker stations and the deficiencies of the loudspeaker above 5000 cycles, resulting in a uniform response from 60 to 7000 cycles over the entire system.

On the schematic layout of the system, the 57 loudspeaker stations are represented as circles "A" and are shown grouped as normally used. Each station has two lines to a jack "B" at the Central Control Station. When a plug is inserted in one of these jacks, the relay at the loudspeaker station is energized and the amplifier turned on. By means of the jack panels "C" any ten stations may be connected together as a group. Provision is made for six groups with as many as ten stations in a group. By patching from "D" to "E" any number of groups may be connected to any one of the three input amplifier channels "F" in the Central Control Station. The mixers "G" may be fed from any of the lines terminating at the jacks "H."

Pickup channels are provided for programs originating in five local stations as well as from the studios of the National Broadcasting Company and the Columbia Broadcasting System. Facilities are also provided for a

[*Please turn to page 283*]

One of the many distinctive types of loudspeaker stations which effectively cover the principal thoroughfares, concessions, and important buildings. By these outlets visitors—or police—can be reached in any part of the out-of-doors



Interior of the central control booth housing the input lines from all parts of the grounds, broadcasting stations and other sources of pickup, plus the record turntables and three 80-db. amplifiers

Installing photocell control

in manufacturing plants. Practical advice from an experienced consultant

By REX D. McDILL
Industrial electronic engineer,
Cleveland, Ohio

THERE is now a very wide field for the application of photocell and electronic devices locally in industry, a field that at present is not over-supplied with talent. It is the most interesting of all forms of engineering because every problem calls for invention. As the art develops the need for invention will be less because there will then be precedents and standards to go by. But at the present time there are no such standards, and every new principle has to be worked out on the job.

▼

JOBS FOR THE INDUSTRIAL ENGINEER TO UNDERTAKE

- **Automatic sorting machines**
- **Automatic inspection machines**
- **Automatic wire gauging**
- **Automatic dimension gauging**
- **Automatic color sorting**
- **Automatic thickness gauging**
- **Automatic hardness testing**
- **Automatic machine control**
- **Automatic production machines**
- **Automatic sorting of electrical units**
- **Automatic control mechanisms**

▲

Creative thinking needed

The electronic engineer who is taking up photocell control work must have inventive ability. Every job will require creative thinking,—and the visualization of a complete working mechanical and electronic device, with every element co-ordinating to do the work planned for it.

The industrial electronics engineer who is taking up such work of photocell and electronic equipment must have inventive ability. Every job will require creative thinking, and unless he can completely visualize a working mechanical and electronic device in operation, functioning in every part—with each mechanical, electrical and electronic element coordinating in doing the work he has planned for it to do, he had better "steer clear" of it. He will find few references to help him out on his problem unless it is a simple one, and if it is simple he will find that in many cases one of the large manufacturers of electronic equipment is already working on his prospect. There is not much money in installing door-openers or counting machines for products. There is good money in building production machines if you know how.

A minor tool on a major tool

Mechanical machines will always be the primary tools in manufacturing. Electronic devices as integral parts of those machines perform functions that cannot be done by mechanical methods. In the photocell and other electronic devices we therefore have developed a minor tool to use on a major tool. Unless you know how the major tool is constructed and can build one, your electronic device is of no value as such. This is the principal thing that the industrial electronic engineer must bear in mind before he tries to convince any manufacturer that he can save him money by building a machine.

The special measuring instrument field is one which does not require a great amount of mechanical knowledge. Meters can be purchased and the engineer can build his own amplifiers. This work requires lots of ingenuity and specialization, but there is a growing demand for instruments to measure everything from hair to steel billets. The only drawback to the work is that it requires lots of thinking to turn out something new, and unless there is a repeat demand the pay is small. It is a good way to get started, but don't figure on making a living off of it the first year.

Functions of electronic devices in industry are limited to instrumentation, inspection and control, and when narrowed down their only function is really *inspection.* The instrument itself is an *inspection tool,* and electronic control devices really inspect before their control functions start. Many factories turn out products that cost more to inspect than the actual cost of material and machine labor. If these products are made in large quantities and require 100 per cent inspection there is an excellent opportunity to devise a machine to do the trick and save money.

Analysis of factory production costs in many instances indicate that inspection costs are often in excess of labor production costs. In one instance where inspection on a product cost $1.17 per thousand pieces, an electronic sorting machine did the job for $.08.

Savings may be indicated by investigation of this service when tooling for the manufacture of a new product.

These are the kind of electronic jobs that pay, but they require special ability.

Study the manufacturer's product

The engineer will find that he will have some difficulty in getting into the average plant. If the plant has its own development department it is an even bet that he won't get in at all! Most manufacturers consider that they have certain ways to do things that are better than the other fellow's and don't want their ways known outside their shop. Therefore examine your manufacturer's product before you go to his plant and try to figure out how he makes it and then find out if you can suggest to him a way to do it better or faster. I don't mean that you have to go into details on how you would build the machine. If you do that you are giving your intellectual merchandise away. Ask for a problem like an inspection job that is giving trouble and you will awaken his interest and get something to think about.

One of the first things a manufacturer wants to know is the "patent situation" as he calls it. The only way an engineer can get along is to guarantee nothing in the way of patentability or freedom from infringement and to claim exclusive rights on everything new that he has developed while working on the machine. If he gives anything else with the machine than the working machine and instructions for its operation and maintenance, he is giving his property away. Sometimes it is necessary to assign a license to the manufacturer for his exclusive use in his industry on a device that is special and developed at a great expense. In that event the engineer should retain exclusive rights for the idea in all other industries and the manufacturer should pay for the cost of obtaining the patent through your attorney. This writer advances no socialistic doctrine when he says that the engineers in the last decade in this country have sold their work for a mess of pottage, and that most of them can learn better business methods from the corner newsboy. Hang on to your intellectual property that is rightfully yours and which will be your main stock in trade if you continue in the profession.

Pricing the finished job

Last, but not least, sell the machine or the idea *for what it does* and *not* what it costs to make. A good way to work is to figure the machine on the basis of what it saves in the course of a year's time when setting the price. And don't forget to include the three-shift periods that will eventually be coming along, the improved quality of the product and other factors that enter into the savings. Then charge for the machine what those savings would be in a year's time. If you can't do it for that, pass up the job, because it is an even bet that there will not be a sale anyway. But if the savings run, say, $6,000 for the year, ask that much for the machine even if it costs only $200 to build. You will not only get the money with greater grace than if you asked $250, but you will get more respect.

"There is no depression

in this business of electronic installation, if you can deliver the goods," says Mr. McDill.

"The hard-boiled factory owner can always dig down for anything that will save him money, no matter how loud he yells for more business and about hard times."

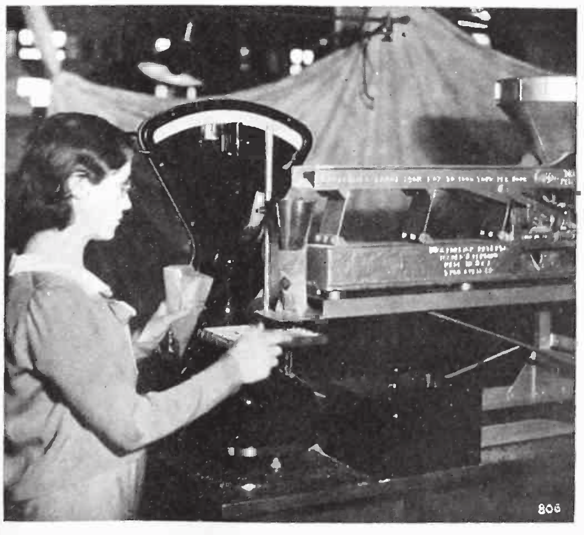
Always get a down payment, guarantee the job, and give the client his deposit back if not satisfied. The biggest credited concern in the country will do that if it believes in you.

A thinker can get more fun out of this work than any other kind of work under the sun. Every day there is something new to play with and think about. There is no depression in this business of electronic installation if you can deliver the goods. The hard-boiled factory-owner or industrialist can always dig down for anything that will save him money, no matter how loud he yells for more business and about hard times.

The "modernization" and "rehabilitation" propaganda that has recently been put out will be a great help. Industry will have fewer machines, smaller and funnier-looking perhaps than those in the past, and the days of mass production haven't even a good start. There is no such thing as modernization in any plant if the industrial electronics engineer is left out of the picture. The six-day week is gone never to return, and the present depression will be forgotten even in the leisure time to come from the thirty-hour week. All progress comes from new ideas and new things to use, and I firmly believe that the new cycle in progress that we are entering will be known as the electronic age.

▼

PHOTO-CELL BAG FILLER



When the pointer on this Toledo scale reads proper quantity, the photo-cell cuts off supply of powder

HIGH LIGHTS ON ELECTRONIC

Minedoors photocell controlled

TWO DOORS IN THE MINE OF THE Buckeye Coal Co. at Nemacolin, Pa., are being operated by photocells. As the locomotive and cars pass along the heading, they intercept a ray of light which is directed toward a photoelectric cell. The interference of another light path sets another train of sequences in operation, by which the door motor is reversed and the door is closed.

At Nemacolin two entirely separate systems of ventilation are employed, receiving their air from different sources and being set in operation by separate fans. Where the cars pass from one system to another, a dead section is provided long enough for the retention of a single group of cars, with some space to spare. The first door is opened, and the cars pass into the neutral or dead section and the door is closed. Immediately thereafter the second door is opened and the cars pass through it, and the second door is then shut.

In order to save time and to avoid the stopping of the cars, and at the same time to provide an unquestioned sequence in the operation of the doors, the photocell method of operation was introduced.

Among the difficulties to be avoided were the discontinuity of the mine train, the cars and locomotive not forming a continuous barrier to a ray of light, and the danger that men passing along the roadway would intercept the light and disrupt the operation of the door, which would begin to open when the man passed the light and be closed long before he reached it.

To obviate the first difficulty the light was thrown at such an angle that the line of the beam when projected on a horizontal plane would be at an angle of 45 deg. to the direction of the heading; thus the light could not fail to be intercepted by the rear end of one car or the front of another when the coupling between the cars was actually abreast of the light. To avoid the operation of the electric eye by the passage of men, the lights were set near the roof and in the center of the roadway, and the electric eye was placed in the lower corner of the heading on the road side, so that a man 6 ft. tall walking on the clearance side of the track, or even on that half of the track thereto adjacent, would not intercept the light with any part of his body, and to make sure that no one would attempt to travel on the light side of the heading, or on that half of the track toward the light side, a guard such as is used to keep cattle off the railroad track was installed immediately beneath the light on both sides of the rail on the light side of the heading.

Three signal lights are provided—red, green and white. Red shows that door is closed, green that it is open, red and white that the door is closing and green and white that it is opening.

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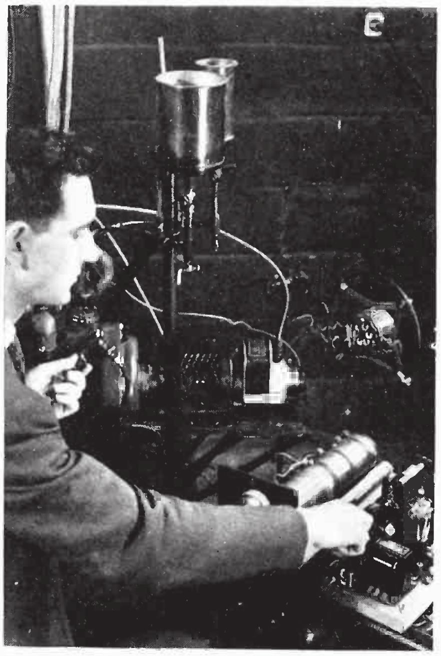
TESTING AUTO ENGINE



Performance of gasoline engines is being studied by means of microphones and amplifier circuits which filter out unwanted sound, enabling tester to concentrate attention on particular mechanical cycle under scrutiny

✦

Air-field wind-vane controlled by photocells

TO AVOID THE DIFFICULTIES with the troublesome standard "wind-sock," which is usually too small to be seen at a distance, and requires that considerable wind be blowing before it will indicate, a large remote-controlled "wind-T" has been experimented with at the Cleveland air-port.

This wind-T is operated from photocell controls on a small and highly-accurate pilot wind-vane. As the pilot vane freely turns about, it covers and uncovers photo-cells governing the movement of the large indicator. In this way difficulties with friction and contacts on the pilot vane have been eliminated.

Photocell traffic signals on bridle path

THE PHOTO-CELL TRAFFIC SIGNALS in Rock Creek Park, Washington, D. C., shown on the front cover of this issue of *Electronics,* have now been in service for a number of months, and have solved an otherwise difficult problem of providing at a dangerous intersection signal lights operated by horseback riders. Regular timed signals could not be set up, since the horseback riders come along at rare and irregular intervals. Contact-mats or treadles for the horses to step on would also have been out of the question. So the photoelectric method was the only one that contained the elements of complete satisfactory service. Two beams are used on each approach, affording one-way operation only, so that the signals work only when horses approach the auto roadway.

The story locally is that at the first installation the photo-cells were placed too low, so that a large dog passing by would operate the signals. This was corrected.

Then, after the system had been in use several months, trouble began to develop in mid-summer from the signals operating in reverse every time a white horse went by. This was finally traced to a patch of sunlight which illuminated the horse's coat, and so signaled the photo-cell. When this sunlight was shaded, the signals resumed their orderly operation, much to the relief of the traffic policemen on the park assignment.

Photo-cell controls have also been used with success to operate gates on bridle-paths. Ordinarily it is a difficult operation to open a gate from on horseback, let the animal through, and close the gate again. But with a photo-cell-operated gate, the rider merely approaches the gate, which swings open and closes behind him.

✦

Radio phones connect up big San Francisco construction job

RADIO TELEPHONES OPERATING ON 4 to 6 meters, and using 6-ft. vertical aluminum rods as antennas, are being used to connect up the various isolated bridge pilings, boats and shore works, preceding the construction of the great bridge and causeway which will connect San Francisco with Oakland, 4 miles away. By means of this system of 22 radio telephone stations, the superintendents can talk to their men at work on any of the piles scattered across the bay, or

DEVICES IN INDUSTRY + +

on the boats carrying materials as they ply back and forth across the bay.

C. H. Purcell, chief engineer, declares that the communication thus afforded to inaccessible points, will greatly reduce expensive trips by messengers and save large amounts of money during the years of bridge construction.

D. R. Tibbetts, an engineering student at the University of California, installed the short-wave telephone system. He also made the first Pacific Coast police radio installation for Chief Vollmer of Berkeley, Calif., in 1927, when he was 16 years old.

✦

Bedroom windows controlled by photocell

Combination of an electric window-closer and a photocell concealed in a small bedside table, make it possible for the bedroom occupant to open his windows by a wave of the hand after he has gotten into bed, and to have them closed automatically next morning by the first flushes of rosy dawn.

One of the first installations of such a photocell window opener is in the lighting exhibit of the Electrical Association of Philadelphia, in the Architects Building in that city. Windows can be opened or closed to any postion, by the duration of the illumination of the photocell. This Cyco window-control unit was also recently shown in the "wonder-house" rooms at Strawbridge and Clothier's store in Philadelphia.

Photocell titration shown in British Museum

A London reader of Electronics wrote to the editorial offices in New York for information on photo-cell methods of controlling large-scale chemical processes handling several hundred tons of solutions daily, and operating continuously. Such information as could be located was assembled and forwarded to him by the next boat.

His next letter explains: "All the data sent are most helpful. A week after I had written, however, I paid a visit to the Science Museum at South Kensington, where I found a model set-up for a parallel operation—for the photo-electric control of chemical titration."

✦

Photocell door opener for household refrigerators?

A photocell door-opener for the household electric refrigerator, by which the housewife can open the door with both hands fully laden, by intercepting a light-beam, is suggested by G. W. Alder, engineer for Good Housekeeping Institute, New York City. The need for such door-opening aids is already being recognized by refrigerator manufacturers in supplying foot pedals, knee levers, and thigh pressure-plates, Mr. Alder points out.

But each of these devices requires that the housewife or maid go through some unnatural action—even to the extent of balancing on one foot, with both hands full, while she operates the pedal-opener. On the other hand, a photocell opener would require merely that the woman approach the refrigerator and—presto—the ice-box door would open, without any effort.

✦

Sheet-catcher with photocell control

Today's cheap automobiles and corrugated iron sheds and roofs typify the influences which, by tremendous increase in demand, have revolutionized the making of sheet steel. Formerly, as sheets were being rolled, at every pass men caught them and thrust them back into the rolls again, a slow, expensive performance.

Then came the continuous wide-strip mill, which poured out rolls of wide steel strip as a paper mill pours out paper. To this the sheet mill now makes response: to catch and return the sheets there is a motor-driven sheet catcher controlled by an electric eye. It is quick work—its 2-hp. alternating-current motor can reverse 40 times a minute.

The electric sheet-catchers, with photoelectric control, shown in the accompanying pictures, are installed at the plant of the Newton Steel Company, Monroe, Mich. Ray Fenton is electrical superintendent in charge.

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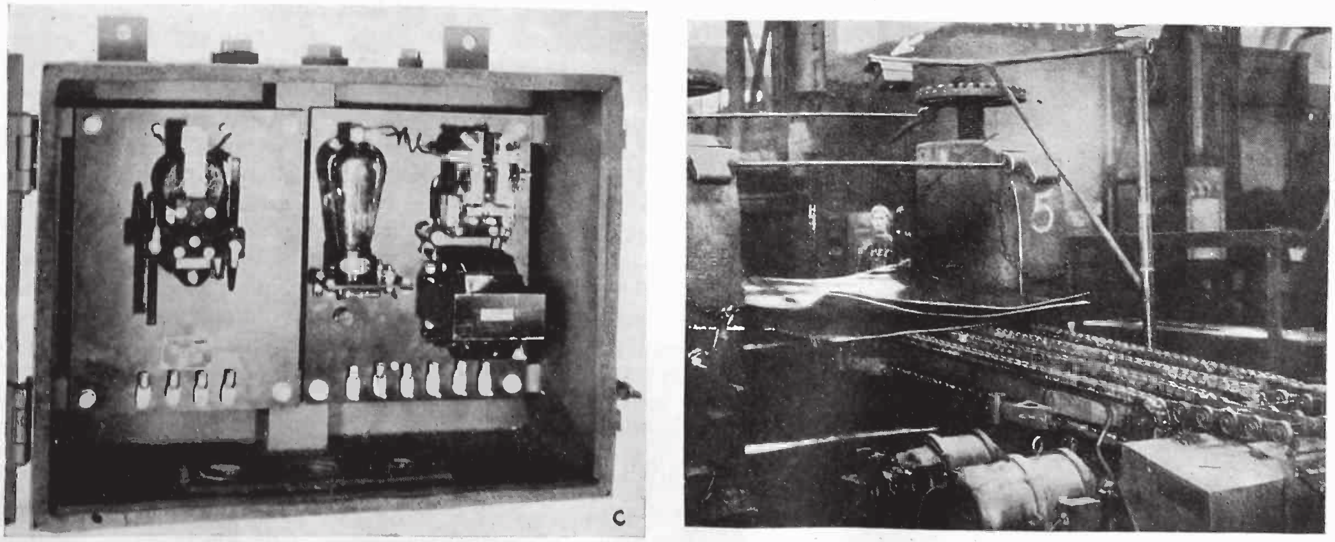
PHOTOCELL TRIGGER CONTROLS HOT-SHEET CATCHER



In place of the mechanical trigger actuated by the impact of the hot sheets in rolling mills, a photocell control has been applied. The light-source is above the table at right, the photo-cell below. The control-panel is pictured at the left

Thermionic cathodes

for gas-filled tubes

By E. F. LOWRY

Westinghouse Elec. & Mfg. Company,
East Pittsburgh, Pa.

IN THE high vacuum type of thermionic device only the simplest forms of cathode structure may be used. This limitation of design is imposed by the negative space charge which builds up in the region immediately surrounding the cathode. If the cathode suface contains any cavities or recesses, the space charge in these depressions may reach such high values that no electrons can escape except under the influence of abnormally high positive potentials. As a result, the only practical way of increasing the efficiency of cathodes for use in high vacuum is by using a thermionically active material which has a lower work of emission for electrons.

In gas or vapor filled tubes this space charge limitation is not so important a factor in design, for the reason that positive ions are constantly falling into the negative space charge region. One positive ion has the capacity of neutralizing the space charge of a fairly large number of electrons. As a result electrons may readily be drawn from deep slots or corrugations in the cathode surface by potentials only slightly greater than the ionization potential of the gas filling the tube, the number of electrons so drawn being limited chiefly by the thermionic emission from the walls of the slot and to a lesser degree by the geometry of the slot.

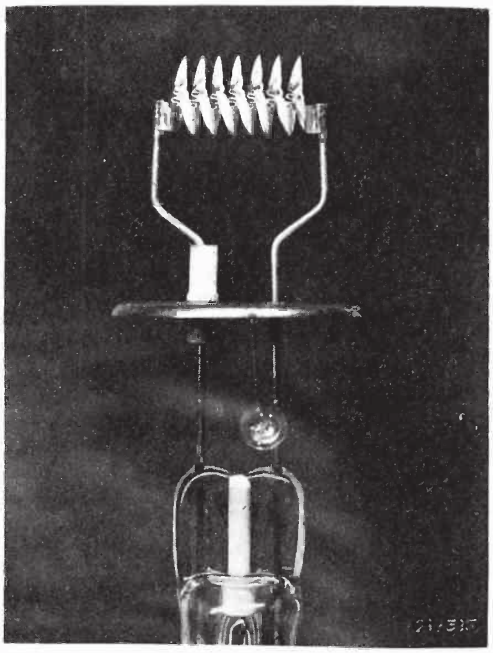


Fig. 1—Helical cathode made from ribbon 14.5 inches long but crimped and compressed into one inch length

Conversely, the walls of such cavities are very poor heat radiators indeed. We come then at once to the proposition that if we fold or crimp a filament ribbon in such a way that it forms a series of parallel surfaces whose separation is small compared to the ribbon width, we will materially reduce the heating energy necessary to maintain our cathode at the desired temperature without impairing the electron emission which it can furnish. Furthermore, such a cathode may be surrounded by one or more suitably designed radiation shields which will still further reduce the necessary heating energy. It is obvious that this method of construction will give large gains in efficiency as figured in terms of amperes of space current per watt of heating energy supplied to the cathode. It is well to bear in mind, however, that this high efficiency is gained at the expense of rapid heating. An increased length of time for the cathode to come to operating temperature is a necessary consequence of the reduced heating energy and, where radiation shields are used, of the increased heat capacity. One must, therefore, choose between high efficiency and short heating time. It is impossible to combine both properties in a high degree in the same cathode. At present the major emphasis seems to be on getting maximum efficiency.

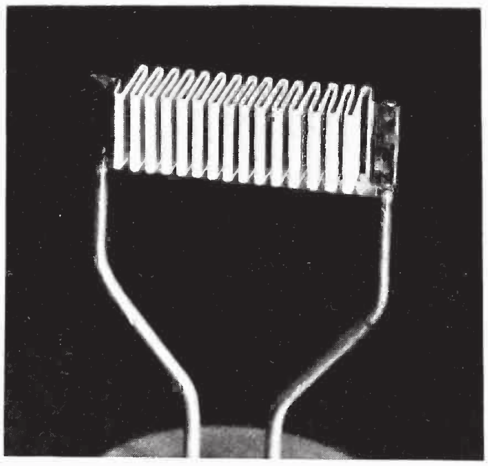


Fig. 2—Filament requiring 200 watts heating energy with a heating time of two minutes and a peak plate current rating of 65 amperes

Another angle to the design of cathodes for this type of service is the problem of mechanical rigidity. We no longer have a simple ribbon stretched between a series of hooks, but a complicated structure made from such a ribbon and which is supported, usually in a horizontal position, only at its two ends. No sagging of this structure is permissible over a lifetime of something like 10,000 hours at an operating temperature in the neighborhood of 900 degrees C. To this end the strongest possible material must be chosen as well as the most rigid type of structure that can be built.

A type of cathode recently developed in this laboratory which fills these requirements reasonably well is shown in Fig. 1. It presents a radical departure in appearance from the conventional filament of the radio or vacuum tube art. The ribbon of which this cathode is formed is 14.5 inches long, yet when crimped and wound into its helical form, a structure is obtained which has a length of only one inch. The reduction in radiating area obtained results in an increase of efficiency of nearly 250 per cent. This filament in the size illustrated, operates at 5 volts 20 amperes, yet has a peak plate current rating of 22.5 amperes, an efficiency of 225 milliamperes per watt. Since it is self-shielding, its heating time is relatively short, 45 seconds. If radiation shields were used to increase the efficiency still further, the heating time would be considerably increased. By a close inspection of the figure it will be evident that the corrugations of the ribbon are not disposed radially, but make a considerable angle with the helix radius. This detail of the design improves the rigidity of the structure.

The material used for the core of this cathode is a nickel alloy called Konel, which has been in use for several years in the vacuum tube field as a core material for oxide filaments. Its mechanical and electrical properties are such at 900 degrees C. that the cathode illustrated has at least five times the mechanical stability it would have had if nickel, for example, were used as a core. Another type of cathode design particularly advantageous when the filament width is at least ½ inch is shown in Fig. 2. This filament, as shown, has an emitting area of 22.5 square inches, yet requires only 200 watts heating energy, or about 9 watts per square inch. If it were stretched to full length, nearly 700 watts would be required to bring it to the same temperature. It has a peak plate current rating of 65 amperes and requires only two minutes heating time.

The peak ratings given for the two filaments mentioned are by no means the maximum electron emission of which they are capable, but represent all it is felt they should be called upon to furnish if they are to meet operating life requirements of 5,000-10,000 hours. It is quite possible to draw emissions as high as 10 amperes per square inch from these filaments without ill effects. It must be understood that other considerations than the maximum emission limit the currents which may be drawn from these filaments. It is not the purpose of this article to discuss these factors, but one at least must be mentioned, and that is the heating effect imparted by the plate current. True, the work done in liberating electrons from the coating has a distinct cooling effect on the filament, but this is far outweighed by the heat developed, at the negative end of the filament at least, by the plate current flowing back into the filament core. This becomes a serious factor when it becomes equal or greater in amount than the size of the filament heating current itself, as it might very well do if the plate current approached the saturation emission value. This then is one of the chief reasons why peak plate current values must be limited to the order of magnitude of the filament current with the average considerably below this figure.

Further gains in efficiency have been attained in the cathode illustrated in section in Fig. 3. Here a filament of the same surface area as that of Fig. 1 has been surrounded by three concentric bright nickel cylinders, which cuts the power required to heat the filament about in half. The inner of these cylinders, having nearly the same surface as that of the filament itself, reaches a temperature of 800 degrees C. or over. It is a simple matter to coat the inside surface of this cylinder with a highly active mixture of barium and strontium oxides. Thus, in one stroke we have cut our heating energy in two and doubled our emitting surface, a gain in efficiency over the filament of Fig. 1 of nearly 400 per cent. That this is not 400 per cent is due solely to the fact that the inner shield cannot of necessity come to quite the same temperature as the filament itself. However, efficiencies as high as one ampere per watt are readily obtainable, which, by the way, represents only 10 per cent of the total energy loss in the tube, so that further gains in efficiency are of minor importance, except in applications where the filament must be operated continuously, though plate currents are drawn only at irregular intervals. This cathode which partakes at once of the nature of directly heated and indirectly heated cathode portions we have called, for want of a better term, a "compound cathode."

A second type of compound cathode is shown in Fig. 3. In this type the greater portion of the cathode is indirectly heated and is enclosed by the filament. This arrangement is the ideal one from the standpoint of uniform temperature. In both the compound cathodes shown it is essential that the indirectly heated portion be negative with respect to the directly heated portion of the cathode during the half cycle that anode current is flowing. This requirement is for the reason mentioned above; viz., that portion of the plate current contributed by the indirectly heated part of the cathode must not be allowed to flow through the heater ribbon before reaching the emitting surface, since it may be several times the size of the heating current used to bring the cathode to full operating temperature. By the simple expedient just described, this difficulty is completely eliminated and only the heating current I_f plus that portion of the plate current emitted from the filament surface itself ever enters the core of the heater ribbon.

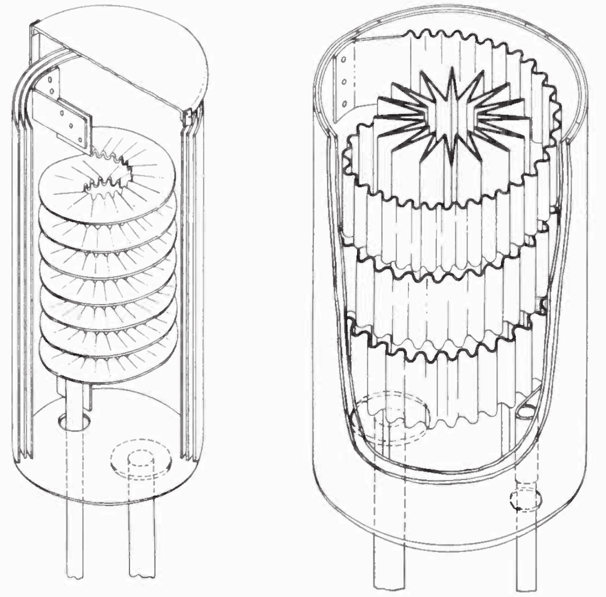


Fig. 3—Left—Filament four times as efficient as that in Fig. 1. Right—Cathode surrounded by the filament and indirectly heated by it

There has been no attempt in this article to give a complete discussion of the problems met in the design of cathodes for gas-filled tubes for the industrial field. We have simply endeavored to show how the demand for cathodes of from a few amperes to several hundred amperes capacity has been met with cathodes of the oxide-coated type which have the required mechanical ruggedness, thermionic efficiency and, for some of the designs mentioned, a proven useful life of over 10,000 hours.

A cold-cathode amplifier tube

By HERBERT J. REICH and WILFRED M. HESSELBERTH

THE recent development of several types of cold-cathode amplifier tubes has focussed attention upon this interesting branch of the field of electronics. Such a grid, properly designed and placed, can control the breakdown of the tube but has practically no subsequent effect upon the anode current except in diverting the anode current to itself if the total current is constant. The "grid-glow tube" and the "thyratron" are examples of tubes which employ grids to control the breakdown. Any difference of potential between the grid and the ionized gas which surrounds it results in the formation around the grid of a space charge of opposite polarity to the grid. This space charge or "sheath" shields the main part of the discharge from the grid, so that the only effects of variation of grid potential are a variation of the magnitude and direction of the grid current, and a corresponding variation in the thickness of the sheath.

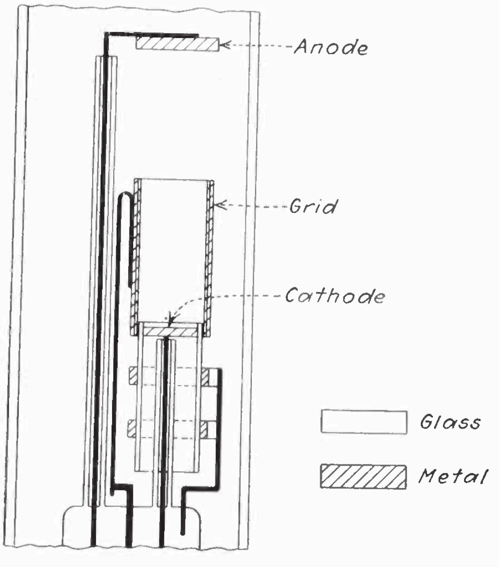


Fig. 1—Cross-section of grid-controlled glow-discharge tube.

Perhaps the most natural method of attacking the problem lies in the introduction of a grid between the anode and cathode of a glow or arc discharge tube. If the total cathode current is fixed by means of a ballast resistance, the grid current does, of course, decrease or increase the anode current, but no amplification is obtained. Under certain conditions it is possible to increase the thickness of the sheaths surrounding individual grid wires to a point at which they become continuous and result in extinction of the discharge.[1]

Preliminary research by one of the writers[2] at Cornell University on the use of a special type of grid in a gas-filled discharge tube indicated that it might be possible to design a three-element gas-filled tube in which the current is at all times under complete control of the grid. More recent work at the University of Illinois has resulted in the development of a tube which, although its characteristics are far from ideal at the present time, nevertheless gives promise of the desired end.

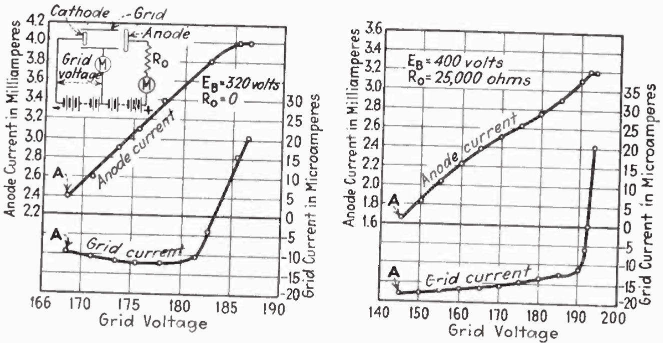


Fig. 2—Mutual and grid characteristics of helium-filled tube. Static at left; dynamic at right

Figure 1 shows the cross-section of one form of this type of tube. Glass insulation of the leads forces the discharge between anode and cathode to pass inside of the cylindrical grid. The tube is filled with an inert gas at a pressure of about 3 to 4 centimeters of mercury.

In the circuit used in obtaining characteristic curves, it should be noted that the potential of the grid is intermediate between that of the cathode and anode and that it is measured with respect to the cathode. The characteristics of individual tubes vary with structure and gas pressure. The static and dynamic mutual and grid characteristics of a typical helium-filled tube are shown in Fig. 2. The anode current is at all times under control of the grid and may be completely extinguished if the grid is made sufficiently negative (points A in Fig. 2). The grid current is small over the operating range; by proper design and choice of gas pressure it may be limited to 5 microamperes. The anode voltage in more recent tubes has been reduced considerably.

This tube differs from the ordinary glow-discharge tube in that with dimensions and gas pressures which are usually used in this tube no ballast resistance is required in the anode circuit. Its function is the same as that of the load or coupling resistance in a high-vacuum amplified tube, and it may be replaced by an inductance.

To date the best mutual conductance that has been obtained is slightly more than 100 micromhos, and the best amplification factor about 4. The tube is quiet in operation and has been successfully used both as an a-f amplifier and as a control tube operated by photocells. The dependence of operation upon positive ion current obviously makes the tube in its present form unsuitable for r-f amplification. The attainment of complete grid control in a simple three-element gas-filled tube appears to be a step forward, and it is hoped that further research now in progress will result in the development of a tube available for commercial use.

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[1] Lübcke; Zeit. für Tech. Phys., 8, 445-449, 1927.
[2] H. J. Reich.

Public address at The Century of Progress

[*Continued from page 275*]

remote control microphone pickup of programs originating in such locations as the studio in the Administration Building, or any one of 25 other locations such as the Floating Theater, the Court of States, Hall of Science, and a number of such concessions as Pabst Casino, Paris, and Old Heidelberg.

The system is a-c operated and consists of five input amplifier channels which supply the 57 loudspeaker stations scattered over the grounds. Five different programs can be broadcast simultaneously from the 57 stations, or these stations may be grouped together in any desired number or location. When occasion demands, all five input amplifiers may be fed from the same source thus sending out programs over the entire system.

Three of the five input channels are located in the Central Control Station at the Hall of Science, one in the Transportation Building and one at Fort Dearborn. The input channels located in the Transportation Building and Fort Dearborn are entirely self sustaining and programs picked up at those locations may be sent to the loudspeaker stations in the territory immediately adjacent. When desired these programs may also be picked up at the will of the operator in the Central Control Station and patched through the main input equipment for redistribution to other parts of the grounds.

Because of the large area covered and the amount of audio power involved, a departure was made from the usual practice of concentrating both the input and power output equipment in one location and radiating therefrom the output channels to the loudspeakers.

Situations arise in which five separate programs are going through the five channels and it is desired to make a general announcement over the entire system and then resume with the five separate programs. To accomplish this with a minimum of effort and loss of time, a break-in arrangement is provided.

The six position mixer of channel "2" is used for the general announcement. Channels "1" and "3" are cut from their mixers and connected to the mixer of channel "2." Channels "4" and "5" are cut from their mixers and connected to the output of channel "2" by means of relays. The complete operation requires the changing of four switches and the operation of the mixer on channel "2." The four switches could be replaced by relays operated by one switch, but greater flexibility is realized with a separate switch for each channel "1", "3", "4", and "5".

The main gain controls of channels "4" and "5" are always set at one position and a pad is in the line coming from the central control station. This means that the operators of these two channels need not touch their controls when their channels are switched in for a general announcement. At the end of the announcement the four switches are thrown back to their normal positions and the original programs continue.

For microphone pick-ups sent to the central control station over short lines, only the microphone and its associated three stage amplifier are used, which gives a level of minus 20 db. For pick-ups sent over longer lines, the microphone and its amplifier are supplemented by a portable amplifier with a three position mixer which supplies the Central Station with a zero level.

The microphone used for this work is a special twelve cell crystal unit. These microphones give excellent reproduction due to their smooth frequency response characteristic and the absence of the strident character of response caused by cavity resonance which is quite noticeable from microphones of the condenser and carbon types. The sensitivity and frequency response are the same in all directions which makes the microphone especially suited for the pick-up of large organizations out of doors.

The entire system is an outstanding example of flexibility, power and quality in a public address system. The quality of sound delivered has been adjudged excellent—even though the steamboat whistle at the Streets of Paris once interrupted a pick-up that sounded like an audio feedback to some alert NBC operator, who promptly cut the circuit.

▼ ▼ ▼

Suppression of auto radio noise

[*Continued from page 273*]

located even a short distance away from the spark plug the noise received would be greatly reduced. Working on this theory a receiver capable of measuring the magnitude of interference was connected to a standard car roof antenna by a lead off the *rear* of the antenna and, consequently, as much out of the field of interference as the antenna itself. It was estimated that with this set-up the maximum noise would be about 15 μv/m. The actual noise measured was over 400 μv. until the wire running to the dome light was disconnected at the dash, and grounded. Under these conditions, the interference was reduced to approximately 20 μv.

The tests indicated the necessity of filtering all wires not directly grounded to the chassis which were in any way associated with the engine's ignition system, and which run close to the receiving antenna. It also indicated that the lead-in wire to the radio set should be thoroughly shielded, as well as the receiver, itself.

At first it was thought that the short lead-in could be shielded without appreciable transmission loss. However, measurements on 10 feet of shielded lead-in showed transmission losses of from 8 to 10 db. As a consequence an impedance matching transformer was designed, with the result that the shielded lead could be used with practically no loss in signal strength.

Having thus uncovered a few facts concerning auto radio interference it remained to make up and try out a few of these systems on various autos. The devices used on these trials were filterettes for the dome or tail light, depending whether a roof or under car antenna was used, and shielded lead-in from the antenna connected to an impedance matching transformer. Care was taken that this lead-in was completely shielded into the set itself. The ordinary spark plug suppressors were also used. Under these conditions measurements showed that the noise was reduced to less than 20 μv.

Thus, much relief can be obtained from ignition noise in practically all auto radio installations by filtering some of the wiring of the car together with stopping all pick-up from the antenna lead.

electronics

McGraw-Hill Publishing Company, Inc.
330 West 42d Street
New York City

O. H. CALDWELL, *Editor*

Volume VI —OCTOBER, 1933— Number 10

New tube types in industry

THERE has been much talk against the introduction of new tube types for radio. This is sound, for simplification of radio tube numbers will best serve the public and the distributing trade that supplies it.

But when it comes to industrial types of tubes, used for a wide variety of functions, and supervised by competent electrical men, the situation is quite different. Tube types for industry are bound to become multitudinous, as tube applications spread in many different directions. Operating conditions will vary, and so special tubes will have to be developed to meet them. Price is less a factor here, because the tube's importance to its surrounding machinery or service is always out of all proportion to the tube's intrinsic cost, even produced in small numbers. In industry specialized service is the watchword, and it will be hopeless to keep tube types down.

Nine times the horizon distance

USING his micro-short-waves, whose "optical" maximum distance of reception should be only about 20 miles measured by any ordinary "horizon," Senator Marconi has been getting distinct reception as far as *180 miles*, or nine times the optical maximum, he said during his American visit. Signals at these frequencies (500,000 kc) he finds *wholly free from static*, even nearby lightning flashes being without audible effect. Fading, however, is severe, and unaccountable in its vagaries, but seems quite independent of daylight or seasons. Still further work is to be done in these very short waves, and the limit of the new micro-waves domain is only the infra-red. Already 3-millimeter waves have been produced, but without actual transmission as yet. Their characteristics are unknown, and may be wholly different from anything we now have. Properties change quickly, even as one goes from, say, 60 cm. to 30 cm., the range of the Marconi micro-waves.

"And, remember—some new discovery tomorrow may upset everything we have today," commented the Marchese as his parting observation.

Something else than "wired radio" —

CONSIDERABLE misunderstanding has resulted from newspaper headlines declaring "Wired radio held illegal in U. S. test case at Bridgeport, Conn."

The facts are that the principle of carrier-current broadcasting, as developed by Wired Radio, Inc., and the telephone companies, using carrier frequencies in the range from 15 to 60 kilocycles, had nothing to do with the Bridgeport case.

There, without a broadcast-station license, the Bridgeport man had operated a regular space-radio broadcast transmitter on 1510 to 1525 kilocycles, except that his antenna was tied into the local lighting circuit. His claim was that he thus produced only impulses in the lighting company's wires, and that this "wired radio" actuated his listeners' sets. At such frequencies of course there was large radiation, and the Government witnesses were able to pick up his programs on Long Island, twenty miles away. Radio sets in Bridgeport also responded to these illicit oscillations, some only at the bottom of the dial, others at four or five critical points on their dials, and still others all along the dial, depending on the principle of operation.

Judge Hincks, of the Federal Court, fined Norman Cohen, station owner, $25 and costs, for producing radio radiation and emanations without a Federal license. The question of non-interfering distribution of programs over wire lines, as contemplated by wired-radio adherents, was not involved in the Bridgeport case.

Photocell life and deterioration

EXPERIMENTERS new to the use of photocells, ask about the expected *life* of these light-sensitive units.

Photocells of the vacuum type which are constructed to show only the normal photoelectric effect, should show no deterioration with life. If the sensitivity of the cell drops down, this can be traced to some impurity, or to some misuse of the cell, such as getting the cell too hot, or liberating some impurity inside the cell, from some cause or other.

Cells of the ordinary commercial types, however, are a little more subject to temperature effects than cells showing the normal photoelectric effect from the metal itself. All alkali metal cells are more or less subject to this, and the caesium cell is particularly affected, inasmuch as the vaporization of caesium takes place at a much lower temperature than is the case with any of the other metals used in the construction of photocells.

A new instrument for the creative musician

VLADIMIR KARAPETOFF of Cornell has just had constructed for himself a novel electronic musical instrument which has possibilities for large expansion among those who delight to play creatively. In fact, with it, a versatile musical genius like Professor Karapetoff can play duets with himself, or might successively build himself into a whole orchestra or brass band, himself playing every instrument that is heard.

The elaborate new Karapetoff device has recording cutting heads for both aluminum and celluloid. The playback is provided with sensitive and prompt volume and speed controls, by pedals, so that the phrasing is under close control. Thus the musician listening to a record on this machine can put his own emphasis on music however recorded. And Professor Karapetoff can record his own masterly piano rendition, and then play this back under new phrasing control, while he accompanies his recorded music with the manual bowing of his violin

NEWS NOTES

Rochester Fall Meeting, I.R.E., Nov. 13, 14, 15,—Papers to be delivered at the Rochester Fall meeting of the I.R.E. are as follows: Development of cathode ray tubes for oscillograph purposes—by H. B. Headrick, R. T. Orth, and C. W. Taylor, RCA Radiotron Company.

Dynamic detection—by Kenneth W. Jarvis, Zenith Radio Corporation.

Some television problems and their solutions—by I. G. Maloff, RCA Victor Company.

Super-regeneration as applied to ultra high frequency reception—by David Grimes and Wm. S. Barden, RCA License Laboratory.

Losses in Electrolytic Capacitors—P. Robinson, Sprague Specialties Company.

Speaker problems in high fidelity receivers—Hugh S. Knowles, Jensen Radio Mfg. Company.

Conditions necessary for an increase in usable receiver fidelity—by Dr. Alfred N. Goldsmith, Consulting Engineer.

Problems in ignition interference suppression—by L. F. Curtis, United American Bosch Corporation.

Current Tube design problems—by Roger M. Wise, Hygrade-Sylvania Corporation.

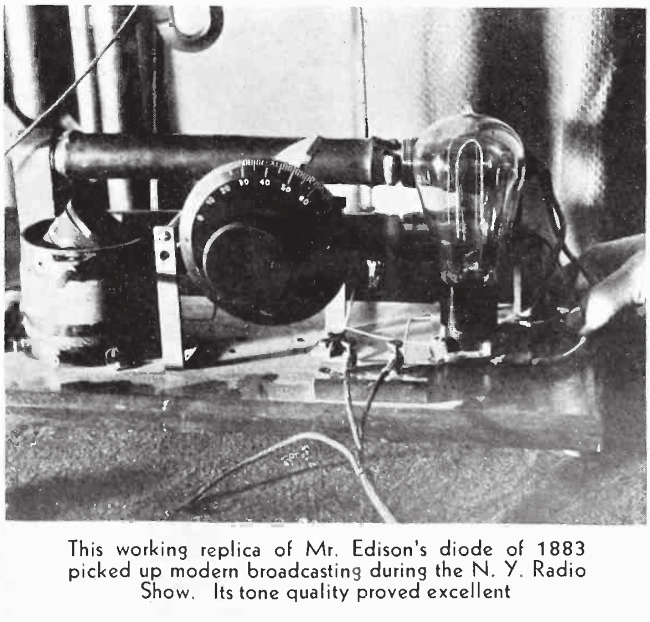
Vibrating rectifiers for "B" power supplies—by C. T. Wallis, Delco Appliance Corporation.

Receivers controlled from stations—Synchronous radio receiving sets, the operation of which is controlled from the broadcasting stations, are being introduced for use in retail stores, especially chains, by Point-O'-Purchase Broadcasting System, Inc., Union Guardian Building, Detroit, Mich. George B. Storer is chairman and treasurer, and Joseph H. Neebe is president.

Mexico authorizes 500-kw. broadcaster—The Secretary of Communications at Mexico City has granted permission to Senor Gumaro Lazarraga, of Matamoros, to construct a 500-kw. radio broadcasting station in Matamoros, according to a report from Vice Consul Henry G. Krausse.

"Edison-effect" lamp as broadcast detector—During ceremonies marking the fiftieth anniversary of Edison's discovery of thermionic emission, conducted by the New York Electrical Society Sept. 28, during the New York Radio Show, this exact replica of the Edison lamp of 1883 was arranged by engineers of the Electrical Testing Laboratories, New York, to pick up local broadcasting. Dr. Clayton H. Sharp, of White Plains, N. Y., former vice-president of the laboratories, and now consultant in electricity and light, recounted Edison's several contributions to the art we now call radio.

MR. EDISON'S DIODE OF 1883

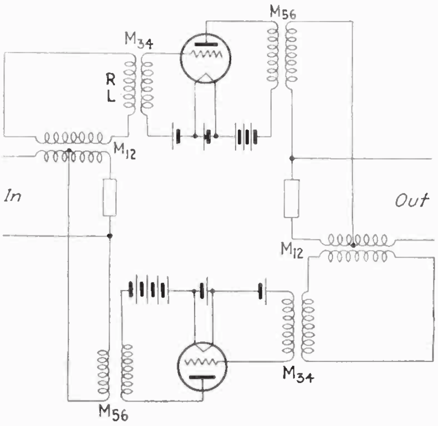


This working replica of Mr. Edison's diode of 1883 picked up modern broadcasting during the N. Y. Radio Show. Its tone quality proved excellent

REVIEW OF ELECTRONIC LITERATURE
HERE AND ABROAD

Electrical properties of the two-wire telephone relay

[A. BYK, Cable Laboratory, German General Electric Company.] The properties of the ordinary symmetrical two-wire amplifying relay are deduced as a function of its surge impedance and velocity of propagation constant, and the conditions for highest amplification are obtained. The formulas arrived at are found to be in good agreement with the experimental results as measured at 800 cycles per sec.—*El Nachr. Techn. 10: 333-344. 1933.*



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Multiple modulation

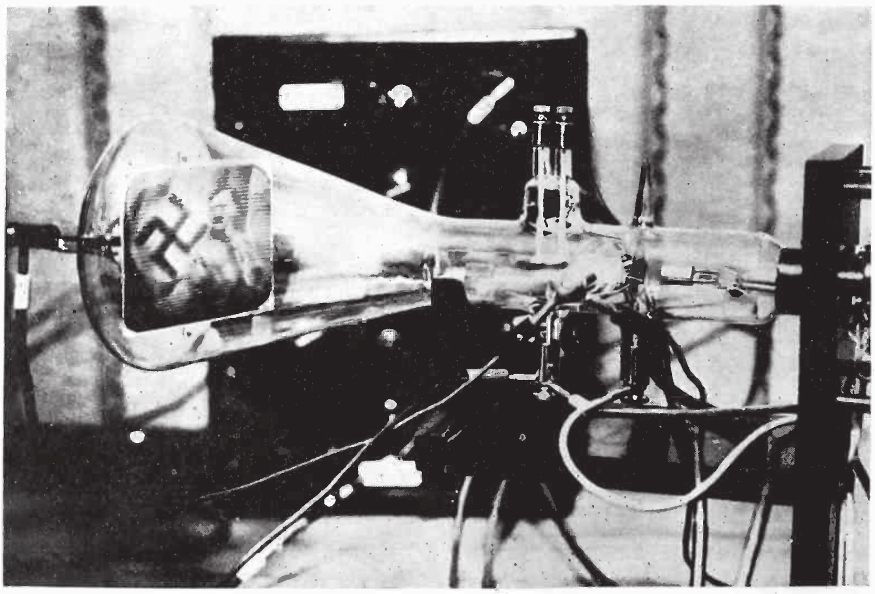
[GEORGES FAYARD, University of Grenoble.] The principle of multiple modulation is to apply the modulated high frequency current to the grid of the first stage of the amplifier, and the amplified modulated high frequency together with a potential proportional to that of the modulating wave and in phase with it to the grids of all the later stages. The result claimed is doubled output for each stage and linear amplification with complete modulation the operating point being chosen in the middle of the straight line portion of the amplifier. Simultaneous modulation of several stages with small percentages of modulation gives a completely modulated and undistorted output.—*Onde cl. 12: 295-325. 1933.*

◆

The screen-grid tube as a detector tube

[J. KAMMERLOHER, Telefunken Laboratory.] When the operating point is chosen near the lower bend of the plate current-grid voltage curve, in such a way that the more positive half of the modulated r-f wave falls upon the nearly straight portion of the curve, whereas the more negative half is practically suppressed the rectified current is proportional at any amount to $\sin^2 pt$. These r-f pulses flow through the by-pass condenser which shunts the plate resistance, the average charging current being equal to $I/4$ per cycle and the voltage drop across the load to $IR/4$ where I is the peak of the plate current. The no-load characteristic curve of the tube is valid for the r-f components, so that $I = \mu E_g$, and the a-f current is amplified in the ratio $\mu R/4$. It is necessary to prevent saturation, which occurs when the plate voltage falls and becomes equal to the screen voltage—that is, $E_p - IR/4$ must be larger than the screen voltage E_s. To be safe R may be taken equal to $4 (E_p - E_s)/I_o$ is the current at zero grid bias. The capacity of the condenser shall not exceed the value $1/\omega R$, when ω, the highest audio frequency, multiplied by 6.28, is to be reproduced with 70 per cent of its strength.—*El. Nachr. T. 10: 345-352. 1933.*

HERR HITLER IS TELEVISIONED

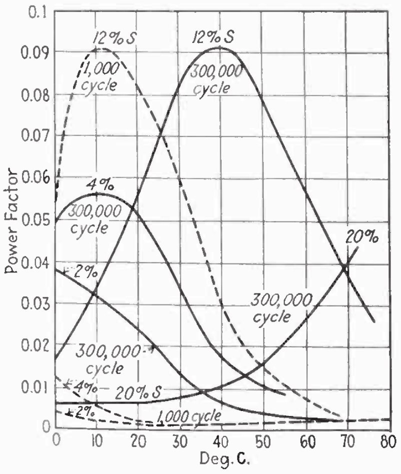


Photograph of picture seen in cathode ray tube of Von Ardenne television apparatus

◆

Electrical properties of rubber at radio frequencies

[A. H. SCOTT, A. T. MCPHERSON AND HARVEY L. CURTIS.] At one frequency the power factor of purified and then vulcanized rubber passes through a sharp maximum at a certain temperature which is higher the higher the frequency. For a sulphur content of less than 1 per cent the maximum occurs below 0° C. for the entire range of frequencies between 0 and 300,000 cycles; the maximum value (0.06) for the 100,000 cycle frequency lies near 0° C. at 4 per cent sulphur; it is of the order of 0.08 for both audio and radio waves when the sulphur content is around 10 per cent. Above 20 per cent sulphur (hard rubber) the power factor remains below 0.01 as long as the temperature remains below 50° C. The dielectric constant has values higher than 2.8 between 0 and 100° C. except when the sulphur content falls below 4 per cent. It reaches the value 4 at 25° C. and 12 per cent sulphur.—*Bureau Stand. J. Research 11: 173-211. 1933.*



BOOKS

FOR ENGINEERS USING ELECTRON TUBES

Conduction of electricity in gases

By Joseph Slepian, Ph.D. Published by the Educational Department, Westinghouse Elec. & Mfg. Company, East Pittsburgh. 188 pages, 180 sketches. Price $4.

An authoritative textbook dealing with the theory of the passage of electricity through gases and stressing the applications in electrical engineering. The text represents notes taken by students in Dr. Slepian's course in the subject given to a specially selected group of physicists and engineers.

The first part of the book, naturally, deals with the fundamentals of electrical conduction in gases. The remainder of the book, the larger part, deals then with the discharges occurring in the form of arcs, glows, sparks and corona. The atomic theory of matter, kinetic theory of gases are developed; ideas of classical mechanics and electromagnetism prevail throughout. Such matters as backfire in mercury arc rectifiers, a-c switching, glow discharge in the vacuum switch are well handled.

Dr. Slepian is known not only as a consulting engineer for the Westinghouse Electric & Manufacturing Company, but even more widely through his publications in the proceedings of learned societies and in the technical press.

◆

High frequency measurements

By August Hund. 1933, McGraw-Hill Book Company. 490 pages, 373 illustrations. Price, $5.

The reviewer's task on facing a book of this nature is second only to that of the author who wrote it; the volume is so large in scope so minute in treatment and so extensive in the subjects handled. But even a cursory appraisal is sufficient to reveal the value of this book not only to laboratory workers but all designers and even manufacturing engineers of high frequency equipment. Some of the chapter headings will be found in other books, chiefly on radio engineering, but there are others which seem to be unique. For example the author has packed nearly 500 pages with details on the measurements of the electrical quantities of voltage, frequency, current, inductance, capacity, effective resistance, power, losses, and has included data on ferromagnetic measurements, descriptions of laboratory oscillators and other equipment, details on the measurement of minute and ionization currents, vacuum and gaseous tubes, modulation, antennas and lines, field strength, piezoelectric apparatus. The volume ends with some 20 pages of tables of various sorts.

Throughout the book will be found typical examples for the measurement under consideration to give the reader a sense of values. There are nearly 400 illustrations, and while it would be unsafe to state that every known method of measuring high frequency phenomena or apparatus is included, the methods omitted must be confined to the unimportant.

Dr. Hund's standing as an engineer and scientist, his authorship of a well known German book on high frequency technique make certain the accuracy, the pertinence, the practical nature of the contents.

◆

Die Kathoden strahl rohre (The cathode ray tube)

By M. von Ardenne. (Verlag von Julius Springer, Berlin, 1933, 398 pages, 432 figures.) Price, bound, 36 marks.

The first hundred pages are devoted to the description of the cathode ray tube, the methods of transforming the very diffuse stream of electrons, obtained with 30 to 3,000 volts on the plate, into a sharp pencil, either by means of a magnetic field produced by an outside coil or by means of the radial electric field formed by the ions (Van der Bijl and Johnson), and the methods of controlling the strength and the direction of the ray. The positive ions create peculiar conditions with regard to the control of the current strength, but as recognized by Ardenne, when a negatively charged cylinder is surrounding the cathode, a close approach to the behavior of the current in the three electrode tube is obtained, a feature which is of value in television work. A similar, but more sensitive control is obtained by applying the control voltage to a separate grid or ring electrode inside the metal cylinder. Origin distortion of the beam deflected by a pair of plates and loss of definition at very high frequencies, are fully discussed; owing to the presence of positive ions between the plates an amount of energy of about 1/100 watt is absorbed for complete deflection. American products dealt with in the section on commercial tubes are the Western Electric tube suitable for voltages below 500 and the tube described by Zworykin in *Electronics* for November, 1931. The sensitivity of present day tubes is given as lying between 0.2 and 2 mm. deflection per volt so that 50 to 500 volts are required for complete deflection.

The deflections obtained are spread out into a curve with the aid of rotating or vibrating mirrors, or more often, with an additional pair of deflecting plates giving either a linear or a sinusoidal time axis, and the entire second third of the book is taken up by a description of the many time-sweep and locking circuits. The use of a gas-filled glow lamp with external grid, in place of discharge tubes and thyratrons, is new and seems to be promising.

The reader not interested in the details of the tube and its circuits may start with the last third of the book which shows the tube at work in various fields, but mainly as a measuring instrument in the study of radio receivers and their circuits and component parts and finally as a tool in picture transmission and television sets. It is to be regretted that in this part of the book a large number of oscillograms have not been provided with suitable scales.

The American literature on cathode ray tubes and circuits is not very extensive and could have been considered and presented more fully the much the more as the author does not limit himself to German periodicals of recognized standing. Articles by the way, are not always cited with the care usual in books of this kind.

In their book on the same subject officers of the laboratory of the British Radio Research Board state (page 4) that such advances as they have been able to make in recent years by application of the cathode ray tube owe much to the ingenuity resource and unfailing friendliness of Baron M. v. Ardenne. We are indebted to the author whose name is often found in *Electronics* for a book which places his rich knowledge and experience at the service of a much wider circle.

+ NEW PRODUCTS

THE MANUFACTURERS OFFER

Relay for self-generating photocell

A NEW PHOTOELECTRIC RELAY using the new Visitron F2 photoelectric cell which operates without external source of voltage and without amplification, is announced by G-M Laboratories, Inc., 1735 Belmont Ave., Chicago. The complete unit, designated as the FSE photoelectric relay, incorporates a Visitron F2 cell, a sensitive relay and an auxiliary electromagnetic relay housed in a small, compact cast aluminum case, $6\frac{1}{4}$ in. by $5\frac{5}{16}$ in. by 4 in. The cell can be mounted behind a glass window in the front of the case or externally at any point within hundreds of feet of the sensitive relay. The unit can be completely weatherproofed.

Because the Visitron F2 photoelectric cell requires no external voltage and no amplification, the unit can be used in locations not served by electric power lines, and since there are no tubes to necessitate replacements, it will operate for long periods without attention. It is consequently of great importance in controlling lighthouse beacons, night lights on boats at anchor, obstruction lights, airway beacons, highway traffic warning lights, electric signs (both battery and power operated), suburban station lights, railway signal lights and street lighting systems.—*Electronics*.

✦

Felt-coated metal sheets

THE D. R. BITTAN SALES COMPANY, INC., 27 Park Place, New York City, is marketing "R-B-M Robertson "bonded metal," ("R-B-M"), a development of the Mellon Institute of Industrial Research, and manufactured by the H. H. Robertson Company of Pittsburgh, Pa. R-B-M is produced by coating ordinary sheet iron with a layer of low-melting-point metal which acts as an adhesive for a coating with suitable fibrous material by a hot pressing operation.

While developed principally for the building industries, R-B-M is of interest to radio and electrical manufacturers as it permits construction of radio cabinets, horns, etc., with the desirable qualities of metal but without the characteristic "metallic ring."

R-B-M may be coated with cotton, wool or hair felts, cork, paper, cloth, asbestos, etc. It may be bent and drawn to the extent permitted by the bare metal and the character of the coating. This material is proposed for the construction of cabinets, baffles, horns, soundproof and fireproof studios, loud-speaker back-boxes, and (using asbestos coatings) heat-resistant metal housings.—*Electronics*.

✦

Noise-reducing antennas for auto radios

THE LYNCH MANUFACTURING COMPANY of 51 Vesey St., New York City, has developed a new line of noise-reducing antennas which diminish motor interference and simplify auto-radio installations. These antennas of various types, including running-board antennas, are equipped with noise-reducing leads, making it possible to locate the antenna so as to reduce engine interference greatly.

The Lynch company has also applied its broadcast antenna system to automobile installations. There are two impedance-matching transformers and a noise-reducing lead-wire which may be attached between the existing aerial and the receiver in a radio-equipped car. The new coupling system is said also to increase the pick-up.—*Electronics*.

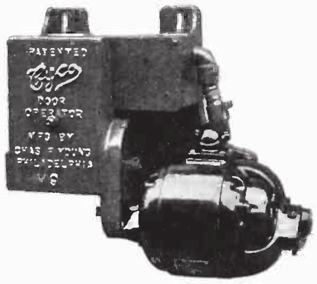
✦

Neon-tube transformers

THE CANATSEY ELECTRIC MANUFACTURING COMPANY, 512-16 Wyandotte St., Kansas City, Mo., has brought out a line of neon-tube transformers, of improved design and long life. The coils are wound on automatic machines and assembled on high-silicon steel cores. Tests include operation of each transformer on open circuit eight hours at 125 per cent of rated voltage. Secondary voltages run from 3,500 to 15,000 volts. A 12,000-volt 30-milliampere transformer, featured by the company, is priced at $4.90.—*Electronics*.

Door-operating motor mechanisms

ELECTRIC MOTOR-DRIVEN door-openers for a wide variety of applications, including control by photocell, sound or radio mechanisms, are built by the Cyco organization, 9 South 36th St., Philadelphia, Pa., headed by Charles F. Young.



In place of having separate photocell channels for opening and closing, this is now provided with a single photocell, operating in conjunction with the Cyco master-switch which keeps the cycles of operation in order. A limit switch is also built into the operator unit. With this equipment any number of photocells or other control contacts can be used in multiple or series.

Use of these door-opening mechanisms has been made in industrial plants and on large estates for operating gates. In one private dairy the doors are automatically opened and closed for each cow as she leaves the milking stable.—*Electronics*.

✦

Wide-area horn

A NEW HORN DESIGNED TO give wide-area coverage has just been developed by the Macy Engineering Company, 1451-39th St., Brooklyn, N. Y. While this horn has been designed especially for sound truck use it is also applicable for airport and stadium purposes. The bell of the horn measures 23 in. in height and 50 in. in width. The horn is exponentially shaped and is 54 inches in length. With this horn an area may be served that would require two horns of the narrow-mouth type. A detachable aluminum throat is provided for attachment of the unit. The horn proper is made of tough weatherproof material which has brass-bound riveted seams and mitered wood trim. The horn composition is a wood-base substance. The standard finish is aluminum. List price, horn only, $50. *Electronics*.

Photocells with tip anodes

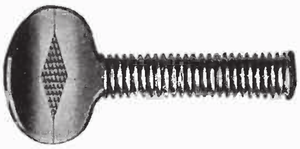
The Continental Electric Company, St. Charles, Ill., has two new photocells with tip connections. The CE-13 photoelectric cell is either filled with argon or is a vacuum cell having the anode rod coming out the top instead of through the stem press. Due to the very high resistance leakage path resulting therefrom the light from a distant star or other very weak lights may be measured. The cell cathode has the usual Cetron caesium-coated silver cathode, which is an extremely sensitive coating. There is an additional support wire brought up through the stem press which can be used to control the current somewhat.

The CE-14 type of photocell also has the anode brought out through the top, and has the anode rod surrounded by a shield grid. This permits the cell to respond to even higher frequencies than the usual Cetron cell. This cell is usually supplied in the vacuum type. The grid may also be used a a control member.—*Electronics.*

✦

Thumb screws

A new construction of thumb screw, adaptable for photo-cell adjustment, has been announced by the Parker-Kalon Corporation, 200 Varick St., New York City. The screw is made in one piece by a new process and is free of burrs and roughness and will take an excellent plated finish. The heads are well shaped and well proportioned. The screws are roll-threaded, come in sizes from $\frac{3}{16}$-24, $\frac{1}{2}$-in. long to $\frac{3}{8}$-16, 3-in. long.



The stock is finished in plain steel, but other standard finishes are available. Special threads, special points, or special metal or alloy screws are available too.—*Electronics.*

✦

Piezoelectric loudspeaker unit

To improve high-fidelity sound reproduction, the Electrophone Corporation, 2019 Rittenhouse Square, Philadelphia, Pa., has announced a piezoelectric loudspeaker unit designed for the distortionless reproduction of the higher audio frequencies. This unit is known as the Mode 4 high-frequency electrophone and comprises a self-actuating piezoelectric diaphragm made of Rochelle salt crystals, a small exponential horn and a self-contained coupling device.

It is to be used with an ordinary low-frequency loudspeaker and can be directly connected in parallel with such a unit without extra networks or filters affording an economical solution of the problem of wide range reproduction. No field excitation or polarizing voltages are necessary,

The low price of this unit will make it attractive to engineers, manufacturers, experimenters, and service men for use in new receivers, to improve existing receivers, public address systems, sound-picture systems, monitors for broadcast studios and electrical phonographs. In theaters the addition of the unit to each sound projector furnishes high-fidelity reproduction from existing equipment, taking full advantage of the recent advances made in high-fidelity recording. This unit is a product of research work of the Boonton (N.J.) Research Corporation. Manufacture is licensed under patents and applications of this corporation and of the Brush Development Company.—*Electronics.*

✦

Adjustable-voltage transformer

The "Variac," pronounced "Vary-ack," is the name of a novel power transformer that gives a-c voltage control with the smoothness of a rheostat and the efficiency of a transformer, and more than any rheostat, it gives a continuous voltage adjustment between 0 and 130 volts when operated from a 115-volt, 60-cycle line.

The Variac has applications in both the laboratory and the industrial fields. A few of its uses include:

1. Brilliancy control on theater and sign-lighting installations,
2. Laboratory source of adjustable voltage,
3. Speed control on small motors,
4. Over-voltage and under-voltage testing on electrical household appliances of all kinds.

The novelty of the Variac is due to the design of a contact mechanism which eliminates the bogey of short-circuited turns which has heretofore made a continuously adjustable tapped transformer an impractical device. In the Variac the turning of a single knob covers the entire range from 0 to 130 volts.

The Variac is made in two models: Type 200-CM has a protecting case, an attachment cord, and an outlet receptacle and is intended for laboratory and experimental use; another model, without the case, is available for those who wish to build the Variac into other equipment. The maximum current rating of this Variac is 5 amperes. Models for larger and for smaller currents are under development. This device is manufactured by the General Radio Company of Cambridge, Mass. Price, $16.50. — *Electronics.*

✦

Photo-electric relay kit

The Argus photo-electric relay in kit form is being supplied by the electronic division of the A. M. I. Distributing Company, 1500 Union Ave., S. E., Grand Rapids, Mich. When assembled this unit can be used for all photo-sensitive controls, including door-openers, signs, lighting, counting, alarms, etc. The unit measures $4\frac{1}{2}$ in. by $5\frac{1}{2}$ in. by $5\frac{1}{4}$ in. high, and weighs 4 lb. The Argus photo-relay kit sells at a list price of $30.

Other accessory apparatus includes a light source (110 v., a.c.) with focussing lens, priced at $10, and the Argus infra-red filter of imported Jena solid-color filter glass, one blue, one red, assembled in barrel-type holder, list price $7.50.—*Electronics.*

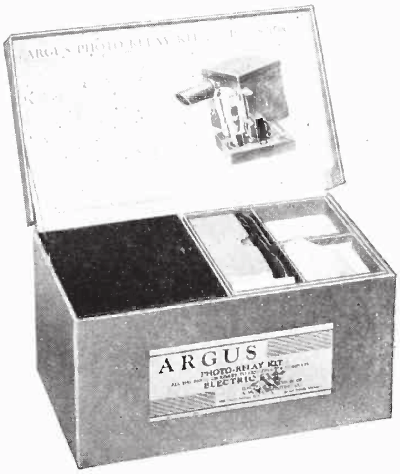


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Photo-electric road switch

A novel road-switch for operation by passing motor cars, which employs a photoelectric principle, has been put on the market by the Tiffin Electro-Mechanical Company, Tiffin, Ohio. This "Hayes treadless road switch" comprises a heavy metal box which is placed in the roadway. It contains a compass magnet which is so positioned that when at rest, the mirror carried by the magnet reflects a beam of light onto a photocell. But if an automobile comes along, the change in the magnetic lines of force produced by the steel car chassis, causes the needle to swing, interrupting the light beam and sending out an operating impulse, the same as if the car had actually passed through an exposed light beam. In this case, however, all parts are enclosed in the road-bed housing. The device is especially designed to respond to slow-moving vehicles, such as cars approaching a garage door or toll-collector's gate.—*Electronics.*

Photoelectric cells

"LUMOTRONS" ARE THE photoelectric cells manufactured and distributed by the Central Scientific Corporation, 4829 South Kedzie Ave., Chicago. Unexcelled performance is warranted by the high ouput gain and low variation, which insure uniform, perfect performance. Lumotrons are guaranteed for a year, but are expected to last two years. Being non-microphonic these cells are without background noise. Sharp, concise tones and overtones are faithfully and brilliantly reproduced. Large volume is assured, even when operating at voltages lower than normal rating, thus insuring longer life. Lumotrons will operate for long periods without attention, according to the makers, and, owing to their rugged construction, do not require exceptional care. Each cell is scientifically tested before it leaves the laboratories, assuring both efficiency and uniformity.—*Electronics.*

Paper condensers to replace electrolytics

THE IGRAD CONDENSER & MANUFACTURING COMPANY, Rochester, N. Y., has been purchased by Continental Carbon, Inc., 13900 Lorain Ave., Cleveland, Ohio. The Rochester plant is being moved to Cleveland, and a complete line of paper condensers will be offered by the same organization that is now distributing Continental resistors and auto-radio suppressors.

Carl Grams, Igrad factory superintendent, has had twenty years' experience in the manufacture and design of paper condensers with Stromberg-Carlson, and will have charge of the production of Continental-Igrad condensers.

The new Continental-Igrad line will include all paper condenser types now in use. An exclusive new development of the Continental-Igrad engineers is a line of paper condensers to replace electrolytic condensers. These are housed in containers of the same size as the electrolytics they replace and will withstand exceptionally high potentials and temperatures.—*Electronics.*

Control of lighting

A RELIABLE AND ACCURATE device that operates to turn electric lights on or off when daylight decreases or increases in intensity to a predetermined value has been developed by the Westinghouse Electric & Manufacturing Company.

The applications for this unit, called the Photolux, are many and vary from insuring adequate office and factory lighting to lending a maximum of advertising value to illuminated signs and show windows that no manual operation ever succeeded in reaching.

Some of the places where the Photolux is applied to turn artificial light on and off, without any supervision are as follows: Offices, industrial plants, show windows, schools, signs, floodlighting installations, street lighting, navigation lights, and airway and airport lighting.

The indoor models of Photolux are housed in attractive panel board cabinets for either flush or projection mounting equipped with locks. Adequate knockouts are provided on all sides of the case and there is ample room for wiring inside the cabinet.

Mounted in the cabinet, in compact arrangement, is a vacuum phototube, a one-tube amplifier, and the necessary auxiliary apparatus.—*Electronics.*

New cement for radio use

A PRACTICAL LIQUID PORCELAIN CEMENT, developed by Henry L. Crowley & Company, ceramic engineers and manufacturers, West Orange, N. J., is available in three consistencies. a cement paste for application with trowel or similar tool; a dipping cement suitable for dipping, spraying or brushing; and a dry powder ready to be mixed with water to the desired consistency. The cement paste is widely employed in radio production assembly for holding small parts in place, doing away with the usual nuts, screws and metal solder, and for filling holes and cracks as a sealing compound. The dipping cement is employed for coating electrical resistors and radio coil forms, as well as for general adhesive purposes.

Setting in a short time without the application of heat, this liquid porcelain is proof against oil, acids, gases, and heat up to 2,000 deg. F. It can be made waterproof and is an excellent electrical insulator.

It is available in small cans for experimenter and repair-shop use, and in large cans and steel drums for bulk users.—*Electronics.*

Self-generating photocell

A NEW SELF-GENERATING photo-electric cell is the outcome of one and one-half years of original research by Edward Praetorius, in the laboratories of the Acousto-Lite Corp., Ltd., 2908 South Vermont Ave., Los Angeles, Calif.

The new cell is of a very convenient form of construction so as to be very easily adaptable to any type of experiment or use. It is hermetically sealed in a gas-filled glass tube of the approximate size and form of the new 230 type radio tubes, and equipped with a neat UX type base measuring 1⅛ inches outside diameter.

The light sensitive element is in the form of a special sensitized plate having an active area of 0.8 sq.in. and the internal d-c resistance of the cell is approximately 100 ohms. Exposed to direct sunlight the cell will generate approximately one milliampere without the aid of batteries or any other source of emf. Thus the cell will directly operate some kinds of electrical apparatus without the aid of amplification, which is usually necessary with other types of photo-electric cells.

The photo-emf. generated by the Acousolite Cell is a straight line function of the intensity of illumination, and it is instantaneous in action. It will readily pick up sound on film, and can be coupled to various forms of amplifiers by simple transformer coupling, no batteries in the circuit of the Acoustolite Cell and transformer primary. The Acoustolite Cell clearly responds to the full range of audio frequencies. While tests are not yet complete with respect to radio frequencies, there is reason to believe that the cell will readily respond to this higher order of frequencies—Price $10.—*Electronics.*

Transposition insulator

A GLAZED PORCELAIN TRANSPOSITION insulator of novel design for use in the feeder lines of anti-noise receiving aerials and transmitting antennas, is announced by the E. F. Johnson Company of Waseca, Minnesota.

Unlike previous devices for this service, the Johnson transposition insulator keeps the feeder wires in a continuous line throughout their length which eliminates the usual tendency for the feeder system to twist and get out of shape. There are no sharp bends at the point of transposition thus imposing a minimum of strain on both the conductors and the insulator and extending the probable life of the line.—*Electronics.*

Recording feed screw

THE UNIVERSAL MICROPHONE COMPANY, Inglewood, Calif., has a universal recording feed-screw device which moves any recording cutting head across the face of the recording disk and thereby grooves the record at the time of making the recording.

This method of making the groove at the actual time of recording is said to have proven far superior to the use of pregrooved records. The device is so constructed that the recording head may be lifted from the record without disturbing the feed screw.

There are no critical adjustments required in the operation of the device, and the instrument will fit any phonograph turntable. Records up to 12 inches in diameter can be accommodated and the thread is cut at the rate of 80 grooves an inch.—*Electronics.*

U. S. PATENTS

IN THE FIELD OF ELECTRONICS

Electron Tubes

Co-planer grid tube. H. A. Pidgeon and J. O. McNally, assigned to B.T.L. No. 1,923,686, filed June 5, 1929.

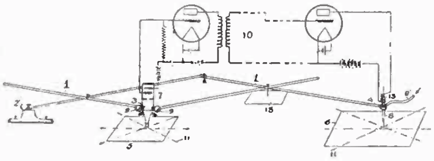
Discharge tube. Use of a hollow metallic anode with relatively low mechanical strength and small heating radiating surface sealed to form an evacuated chamber in which is a cathode and a hollow outer vessel of relatively high mechanical strength and large radiating surface enclosing the anode, but insulated from it. Carl J. R. H. von Wedel, Berlin. Assigned to Electrons, Inc. No. 1,923,521.

Discharge tubes. Gaseous tube of the controlled discharge type in which is a temperature responsive means for rendering the control element inoperative to prevent the flow of current when the temperature rises above a predetermined point. P. L. Spencer, assigned to Raytheon, Inc. No. 1,923,335.

Photoelectric cells. Patents by R. C. Rentschler, assigned to Westinghouse Lamp Co. No. 1,923,844 and 1,923,845 on photocells responsive to wavelengths less than 3000 angstroms.

Electronic Applications

Pantographic scanning. Method of associating a light-sensitive tracing media and a cutting tool by means of an amplifier. Walter Howey, New York City, N. Y. No. 1,923,208.



Height indicator. Determining the height of an all-metal aircraft by electrical means symmetrically placed with respect to the metal surface, and positioned to be inductively coupled to the surface to induce oscillatory current therein. R. A. Fessenden, Bermuda. No. 1,924,032.

Power Apparatus

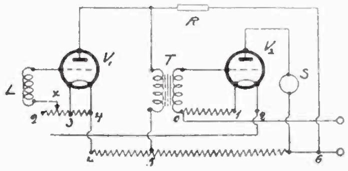
Power conversion apparatus. Including a d-c and a-c circuit using three electrode tubes of the gaseous type. C. H. Willis, assigned the G. E. Co. No. 1,923,696.

Phase device. Method of deflecting a cathode ray beam by means of a phase shifting network. A. H. Brolly, assigned to Television Laboratory, Inc. No. 1,923,252.

Keying system. Method of removing by means of a key the positive potential on space charge grid. J. D. Wallace, Washington, D. C. No. 1,923,345.

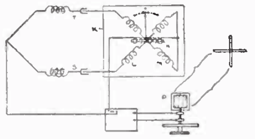
A.c.-d.c. system. A vibrating system for producing a.c. from a d.c. source. E. L. Barrett, assigned to Utah Radio Products Co. No. 1,924,082.

Hum elimination. Method of eliminating ripples in cascade amplifiers. E. O. Löfgren, assigned to Ericsson. No. 1,923,222.



Radio Circuits

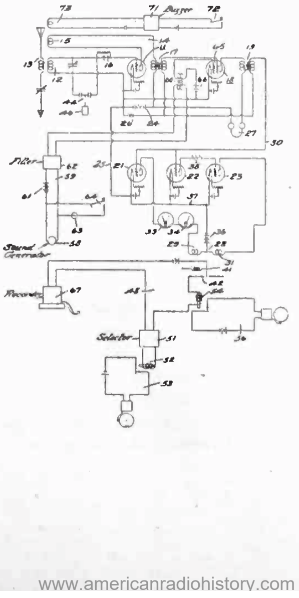
Course shift indicator. Method of shifting the course indicator on a double modulation radio beacon. H. Diamond and F. W. Dunmore, assigned to the Government of the United States. No. 1,923,920.



Selective system. Combined electric and electro-mechanical frequency selecting devices. P. R. Coursey, assigned to Radio Patents Corp. No. 1,923,354.

Course shifting system. A method of shifting two radio beacon courses from their normal 180 degree displacement to align them with two airways intersecting at a radio beacon at an angle other than 180 degrees which consists of introducing circular radiation into the normal figure of a radiation from the beacon. F. G. Kear, assigned to the Government of the United States. No. 1,923,934.

Navigation aid. Method of making a receiver sensitive or not sensitive to distress signals, or to conventional telegraphic signals. W. N. Flanning, Alameda, Calif. No. 1,923,430.



Electro optical register. Use of a piezo-electric axis, coupled with a recording circuit, and optical means adapted to cooperate with the crystal. Alexis Guerbilsky, Paris, France. No. 1,923,619.

Interstate system. Method of resonating part of an inductance for rejecting energy of a wavelength on one side of a selected wavelength. W. T. Lewis and A. R. Woolfolk. No. 1,923,155.

Patent Suits

1,173,079, E. F. Alexanderson, Selective tuning system; 1,195,632, W. C. White, Circuit connections of electron discharge apparatus; 1,251,377, A. W. Hull, Method of and means for obtaining constant direct current potentials; 1,728,879, Rice & Kellogg, Amplifying system; 1,573,374, P. A. Chamberlain, Radio condenser, D. C., E. D. N. Y., Doc. E 6721, Radio Corp. of America v. Vim Electric Co., Inc. Constant decree for plaintiff, June 29, 1933.

1,195,632, W. C. White, Circuit connections of electron discharge apparatus; 1,251,377, A. W. Hull, Method of and means for obtaining constant direct current potentials; 1,297,188, I. Langmuir, System for amplifying variable currents; 1,728,879, Rice & Kellogg, Amplifying system; 1,811,095, H. J. Round, Thermionic amplifier and detector; Re. 18,579, Ballantine & Hull, Demodulator and method of demodulation, filed June 23, 1933, D. C., S. D. Calif. (Los Angeles), Doc. E 12-J, Radio Corp. of America et al. v. D. W. Rogers (Los Angeles Radio Mfg. Co.) et al.

1,231,764, F. Lowenstein, Telephone relay; 1,618,017, same, Wireless telegraph apparatus; 1,403,475, H. D. Arnold, Vacuum tube circuit, D. C., E. D. N. Y., Doc. E-6720, Radio Corp. of America v. Vim Electric Co., Inc. Consent decree for plaintiff June 29, 1933.

1,105,924, Pridham & Jensen, Telephone; 1,266,988, same, Amplifying receiver; 1,448,279, 1,579,392, same, Electrodynamic receiver, D. C. Minn. (St. Paul), Doc. E 1562, The Magnavox Co. v. Wright-De Coster, Inc. Dismissed April 4, 1933.

1,455,141, Lowell & Dunmore, Radio receiving apparatus, D. C. Del., Doc. E 664, Dubilier Condenser Corp. et al. v. Radio Corp. of America. Decree upon mandate of Circuit Court of Appeals, dismissing bill June 29, 1933.

1,635,117, F. W. Dunmore, Signal-receiving system, D. C. Del., Doc. E 663, Dubilier Condenser Corp. v. Radio Corp. of America. Decree upon mandate dismissing bill June 29, 1933.

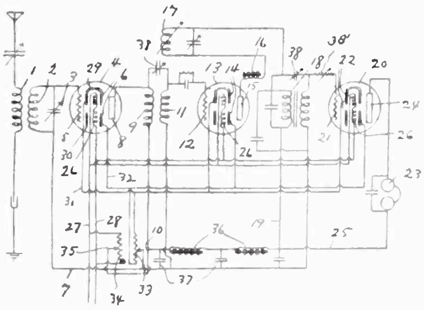
1,231,764, F. Lowenstein, Telephone relay; 1,618,017, same, Wireless telegraph apparatus; 1,403,475, H. D. Arnold, Vacuum tube circuit; 1,465,332, same, Vacuum tube amplifier; 1,573,374, P. A. Chamberlain, Radio condenser, filed June 23, 1933, D. C., S. D. Calif. (Los Angeles), Doc. E 11-C, Radio Corp. of America et al. v. D. W. Rogers (Los Angeles Radio Mfg. Co.) et al. Same, D. C., S. D. N. Y., Doc. E 76/56, Radio Corp. of America, Inc., et al. v. Insuline Corp. of America. Consent decree for plaintiff (notice July 13, 1933).

Power, Amplification, Etc., Circuits

Sub-harmonic producer. Crystal-controlled oscillator and method of using a charged condenser for producing a wave having a frequency with a sub-multiple of the typical frequency. W. A. Morrison, assigned to B. T. L. No. 1,919,795.

Hum prevention. Method of diminishing a-c noise in vacuum tube circuits. Walter Schaffer, assigned to Telefunken. No. 1,919,598.

Amplifier-rectifier system. Combination of circuit with tubes having grid and plate electrodes and two emitters in which rectification and amplification take place within the same tube. M. E. Macksoud, assigned to the Electron Corp., July 3, 1926. No. 1,920,576.



Interstage system. An r-f coupling system comprising a transformer with a tuned secondary and primary which is resonant lower than the lowest frequency within the tunable range. E. A. Beane and E. F. Andrews, assigned to RCA, filed June 17, 1924. No. 1,920,342.

Inverter system. Method of operating a synchronous machine from a non-synchronous supply source by rectification and inversion. C. W. Stone, Feb. 17, 1931, assigned to G. E. Co. No. 1,920,814.

Signaling systems. Patents Nos. 1,921,087 and 1,921,088 to W. A. MacDonald, assigned to Hazeltine Corp., on multi-stage amplifier systems of a superheterodyne nature.

Relaxation oscillator. Use of a three-grid tube, the inner grid biased to prevent the tube from operating at the point of saturation. R. M. Paige, Washington, D. C., July 13, 1929. No. 1,921,476.

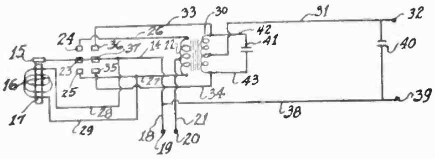
Translation circuit. The method of using grid-controlled vapor electric tubes for inversion. August Schmidt, Jr., assigned to G. E. Co., May 24, 1932. No. 1,921,704.

Receiving system. A receiver for an oscillation whose frequency is constant and whose phase assumes alternatively two values in opposition. H. J. Bellestive, France, Feb. 24, 1932. No. 1,922,282.

Amplifier voltage control. Method of using two-element valves for regulating a-c generators and for amplifying. F. H. deJong, assigned to Philips, May 19, 1930. No. 1,922,794.

Super-regenerative receiver. Regenerative detector, oscillatory circuit having a steep wave-front and means for coupling these two circuits together. C. A. Gunther, assigned to G. E. Co. No. 1,917,113, filed April 28, 1932.

Direct-current voltage transformer. Method by which direct current is interrupted by a vibrator sent through a transformer to step up the voltage and it is then rectified by other contacts on the vibrator. R. J. Rockwell, Crosley Radio Corp. No. 1,920,150, filed Dec. 7, 1932.



Electron tubes

Glow lamps. Several electrodes within a bulb one of which comprises a coating of nitrided alkaline earth material and a gas within the bulb comprising a high percentage of helium and a comparatively low percentage of nitrogen. T. W. Case, assigned to Case Research Laboratories, July 27, 1929. No. 1,923,051.

Tube tester. Process of determining the mutual conductance of a vacuum tube consisting in impressing upon the grid an alternating current rectifying the alternating component in the plate circuit and measuring the rectified current. October 31, 1930. No. 1,920,906. W. N. Goodwin, assigned to Weston.

Co-planar grid. A two-grid tube, one of which applies a positive biasing potential of as much as 25 volts. H. A. Pidgeon and J. O. McNally, assigned to B. T. L., June 5, 1931. No. 1,920,274.

Tube construction. Cathode surrounded by a heating element and heated by direct radiation, a shield electrode between the heater and the grid of the tube and the plate being positioned on the opposite side of the shield from the heating element. C. J. Kay, assigned to Spark-Withington, No. 1,921,619. See also No. 1,921,620 to Kay on a glow tube.

Short-wave apparatus

Shielding system. Device for preventing external electrostatic capacity from disturbing radio signaling apparatus comprising a shield and a ground connection of such length as would produce a voltage node on the shield at the frequency of the signaling wave. J. O. Watson, assigned to International Communications Laboratories, September 16, 1930. No. 1,920,223.

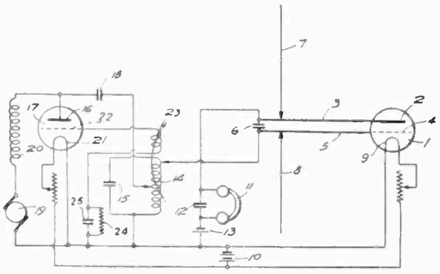
Wave meter. A micro-ray wave meter, comprising two sections of transmission line of fixed length and a section of transmission line of variable lengths intermediate two sections wherein for the range of frequency to be measured the characteristic impedance of the variable length sections is large as compared to that of either fixed length sections. R. H. Darbord, assigned to International Communications Laboratories, July 10, 1931. No. 1,921,117.

Short wave oscillation generator. A telescopic inductance in the form of a circle comprising two sections, one movable with respect to the other. R. Baranowski, Berlin, assigned to Telefunken, September 5, 1930. No. 1,921,448.

Ultra short wave receiver. A two-tube receiver, the first having a positive grid and free anode to produce ultra high frequency oscillation directly coupled to the second amplifying tube. H. E. Hollman, A. T. & T. Co., October 22, 1931. No. 1,921,187.

Transmitting tube. An ultra short wave circuit for transmitting oscillations of the order of one meter and less in length comprising a tube with a high positive potential to the control electrode and a lower potential to the anode the surface of the control electrode being treated for aiding thermal radiation and the anode being perforated whereby there is obtained a reduction in the capacity between anode and control electrode. Fritz Schroeder, assigned to Telefunken, March 9, 1933. No. 1,921,640.

Super regenerative receiver. W. J. Brown, assigned to Associated Electric Industries, Ltd. No. 1,922,195, July 11, 1928.



Patent Suits

1,195,632, W. C. White, Circuit connections of electron-discharge apparatus; 1,251,377, A. W. Hull, Method of and means for obtaining constant direct current potentials; 1,728,879, Rice & Kellogg, Amplifying system; Re. 18,579, Ballantine & Hull, Demodulator and method of demodulation; 1,811,095, H. J. Round, Thermionic amplifier and detector, D. C., S. D. N. Y., Doc. E 75/346, Radio Corp. of America et al. v. Radio Syndicate Co., Inc. Consent decree for plaintiff (notice May 27, 1933).

1,231,764, F. Lowenstein, Telephone relay; 1,465,332, H. D. Arnold, Vacuum-tube amplifier; 1,573,374, P. A. Chamberlain, Radio condenser; 1,618,017, F. Lowenstein, Wireless telegraph apparatus, D. C., S. D. N. Y., Doc. E 75/345, Radio Corp. of America et al. v. Radio Syndicate, Inc. Consent decree for plaintiff (notice May 27, 1933).

Adjudicated Patents

(C. C. A. N. Y.) Cohen patent No. 1,563,893, for multiple variable condenser, Held invalid. Id.

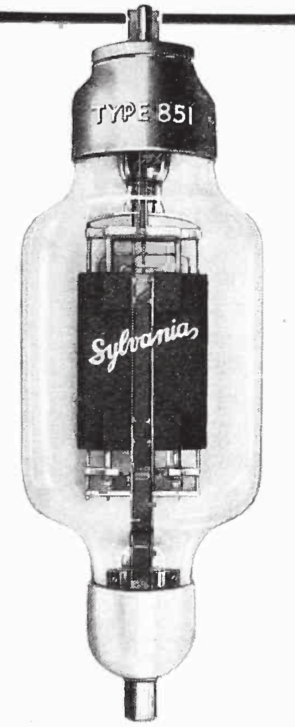
(C. C. A. N. Y.) Georgiev patent, No. 1,789,949, for electrolytic cell, claims 11, 12, 19, and 20 Held valid and infringed. Aerovox Corporation v. Concourse Electric Co., 65 F.(2d) 386.

(C. C. A. N. Y.) Georgiev patent, No. 1,815,768, for electrolyte, claims 8, 9, 10, and 14 Held valid and infringed. Id.

A typical *Sylvania* development

(Reg. U. S. Pat. Off.)

GRAPHITE ANODE TUBES!



Type 851—the largest graphite anode tube ever made! One of Sylvania's complete line of Graphite Anode Tubes.

● A new process developed in the Electronics Laboratory of Hygrade Sylvania Corporation enables us to treat carbon in such a manner that it is reduced to pure graphite with all amorphous carbon and other impurities removed. This revolutionary contribution of Sylvania engineers now gives radio science a complete new line of transmitting tubes with the following major advantages:

1. High plate dissipation without over-heating . . . a direct result of graphite's high thermal emissivity.
2. Lower operating temperature at anode and, consequently, at other electrodes. Prevents secondary and primary emission from the grid.
3. Uniformity of characteristics. Physical properties of graphite permit exact processing and obviate distortion. Relation between tube elements remains constant. Normal electrical characteristics preserved.
4. Long life. Graphite's comparative freedom from gas permits high vacuum . . . gives longer tube life.

It was for the purpose of just such development work in all fields of electronics that Hygrade Sylvania instituted a special Electronics Department.

Early this year, a separate plant in Clifton, N. J., was established for the design and production of radio transmitters, transmitting tubes, industrial power tubes, and custom-built electronic devices.

We invite inquiries concerning special electronic problems or equipment. Eminent Sylvania engineers will cooperate with you.

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BRITISH PATENTS
IN THE FIELD OF ELECTRONICS

Radio and Television Circuits

Superhetrodyne. The local oscillator is provided with mixed magnetic and capacity back coupling whereby its output frequency characteristic over the tuning range may be arranged to compensate for or be otherwise correlated with the amplification frequency characteristic of the RF amplifier. W. A. MacDonald, Hazeltine Corp., No. 391,521.

Automatic volume control. A full-wave attenuator connected across a line for compressing or expanding volume to enable the signal to comply with the limitations of the apparatus in the system which may be a transcontinental, short-wave broadcasting, or cable circuit. A. Pfister, Marconi Co. No. 391,681.

Detector-amplifier. A tube with high frequency potentials applied to cathode and anode to rectify voltages applied to one grid and amplify low frequency energy is taken from the second grid. Marconi Co. No. 391,979.

Screen-grid circuits. Degree of damping in an amplifier employing screen-grid tubes is reduced by coupling the screen-grid circuit of one tube to the same circuit of the succeeding stage. Ideal Werke Akt. No. 392,045.

Modulation measurements. Direct currents are established proportional respectively to the crest and average voltages of the modulated wave and the degree of modulation is deduced from a comparison of the values of the two currents. The high-frequency currents are impressed on grids on two tubes across an inductance. The grid leak and condenser of one detector has a time constant so large that the peak voltage is maintained on the second tube. C. F. Elwell and F. E. Terman. No. 392,053.

Crystal oscillator. To obtain stable operation the anode of the tube is coupled to the tuned grid circuit in reverse in such a manner that oscillations could not occur without the inclusion of the piezo-electric crystal. British Thomson-Houston Co. No. 392,436.

FIG.1.

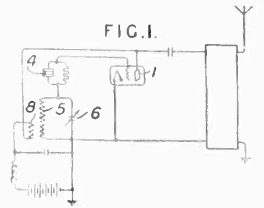
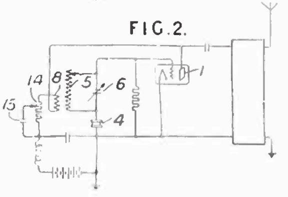


FIG.2.



Television system. Television and sound signals are transmitted on neighboring carrier frequencies, for example, 50,000 and 51,000 kilocycles and both carrier frequencies are received by damped circuits in a superheterodyne. All the television signals are passed by a detector to control the emission in a cathode ray tube but other detectors are biased to respond only to the peak of the horizontal and vertical scanning frequencies. Marconi Co. No. 392,456.

Cathode ray tubes. A tube with an internal wall which divides the tube into two air-tight compartments and formed of a number of transverse conductors so that it has a higher conductivity transversely than in other directions, the cathode ray being diverted against one side of the wall and an auxiliary anode being arranged in the gas-filled compartment remote from that in which the ray is produced, the intensity of the glow varying with the intensity of the impinging ray. British Thomson-Houston Co. No. 392,583.

FIG.1.

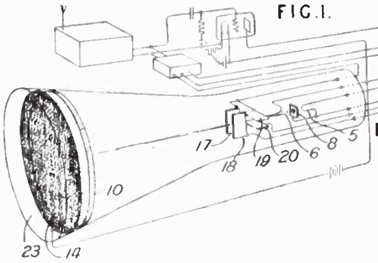
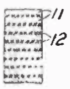


FIG.3.



Short wave circuit. An ultra short-wave circuit comprising a pair of Barkhausen-Kurz oscillators the grids of which are connected through a tuned Lecher-wire circuit to points on each side of the center point of the dipole aerial so as to match the surge impedance. The anodes of the valves are interconnected through a Lecher-wire circuit while the filaments are similarly interconnected. When used for reception, the dipole aerial is connected to the anode instead of to the grid. Marconi Co. No. 392,210.

Modulating system. The low-frequency modulation current applied to a carrier is maintained approximately constant by the use of variable-mu tubes whereby the modulation level is maintained at a deep value and overloading of the transmitter when the signal intensity is high is prevented. Marconi Co. No. 392,230.

Television amplifier. Frequency response characteristic peaks at or about the line scanning frequency and its harmonics. The major peak occurs at the line scanning frequency and the other peaks decrease in size as the order of the corresponding harmonics increases. The amplifier incorporates one or more tuned coupling circuits of high decrement and resonant at the line scanning frequency. Marconi Co. No. 392,229.

Superheterodyne. An oscillator-modulator comprising a feedback coupling so proportioned that oscillations of constant amplitude are produced and are insufficient to render the grid positive. Hazeltine Corp. No. 392,841.

FIG.1.

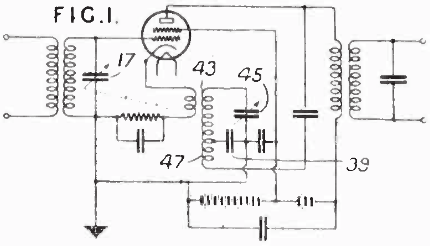
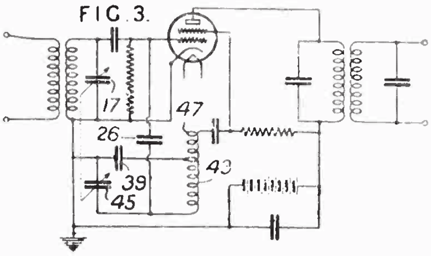


FIG.3.



Hum prevention. Cathode of a heater type tube is made two or more volts negative with respect to the filament, sufficient to saturate the space charge between them. No. 392,866. Telefunken.

Automatic volume control. The a.v.c. voltage is produced by a resistance whose magnitude varies in acordance with the received signal strength. Marconi Co. No. 393,318.

Distance finder. The distance between a transmitter and receiver is determined by comparing the signal strength at the receiver of two signals of the same frequency but of different attenuations from the transmitter or of one of the signals and the radiation from a local oscillator. E. G. Gage, Booklyn, N. Y. No. 393,344.

Modulation system. Plate current at a transmitter tube is fed from a triode which has both its grid and plate excited at a supersonic frequency. The microphone being arranged to vary the phase relation between the grid and plate excitation. G. E. Co. No. 393,379.

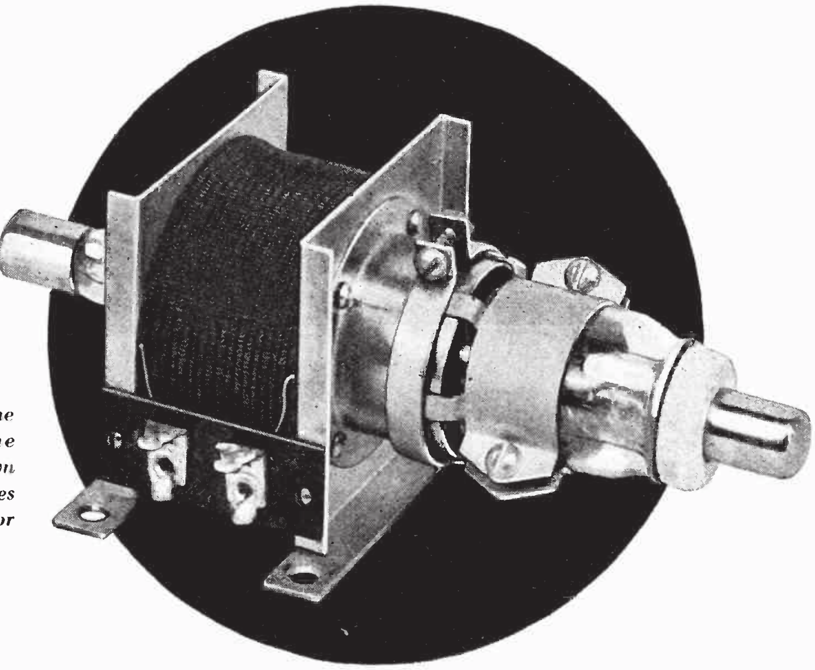
Short-wave systems. Various systems for handling the wavelengths of the orders of decimeters down to the infra-red. Standard Telephones. No. 392,962.

Apparatus control. Use of light rays for switching on lamps as daylight fades maintaining liquids at a definite transparency or dying materials to a uniform color by means of light sensitive cells. A. W. Isenthal. No. 393,248.

Television system. In a cathode ray television receiver the visible return traced by the cathode ray are eliminated. Marconi Co. No. 392,383.

Superheterodyne circuits. An intermediate frequency amplifier has one inter-valve transformer coupling designed to give a double resonance and one or more succeeding transformer couplings desiged for single resonance the over-all response being substantially uniform over the side-band range. W. A. MacDonald, Hazeltine Corp. No. 392,411.

NO DANGER
OF ARCING



Developed by Bell Telephone Laboratories for airplane radio, 244A Relays have flown many hundred thousand miles without record of arcing or failure of any kind.

. . . with this *fast, dependable* relay

The Western Electric 244A Relay rapidly opens any high voltage, low current circuit — contacts moving only 1/16 inch. All moving parts are enclosed in a highly evacuated tube, which assures long life, prevents arcing, gives a clean make and break. This is especially important where circuits must be opened in explosive or rarified atmosphere.

The 244A Relay consists of a 706A Vacuum Switch mounted in a solenoid, wound for operation on 12 volts D.C. Switch closes by means of the magnetic field. Coil resistance is approximately 26.5 ohms. Connections for the high voltage load circuit are made directly by means of standard grid clips on the ends of the vacuum switch.

Small (4-1/2″x2-3/8″x1-13/16″), light (18 oz.) the 244A may be mounted in any position. Being controlled remotely, it safeguards the operator against high voltages. Although used in the 13A Aircraft Transmitter to break 1250 Volts at 1/2 ampere, it can be conservatively rated for interrupting peak voltages as high as 2500 Volts.

Send the coupon for further details.

Western Electric

ELECTRONIC EQUIPMENT

Distributed by* GRAYBAR *Electric Company

E. 10-33

GRAYBAR ELECTRIC CO.
Graybar Building, New York, N. Y.

Gentlemen: Please send me full information on the Western Electric 244A Relay.

NAME ....

ADDRESS ....

CITY .... STATE ....

Electronics Readers

are cordially invited to investigate the Research and Development Laboratory facilities of the

RCA Radiotron Company, Incorporated

A radio tube is no better than the laboratory facilities behind it. RCA Radiotron Co., Inc., believes that the excellent reputation of its product is due to its superb technical talent and equipment—its unsurpassed laboratory facilities. We invite you to investigate them through the medium of these pages.

Systematic Development and Application of Radio Tubes

The Research and Development Laboratory of RCA Radiotron Company, Inc., at Harrison, N. J., is necessarily organized on a broad basis. While the primary functions of such a laboratory are to develop new types of tubes for broadcast and amateur use, and to perfect existing types, a conscientious and vigorous application of this program leads into almost limitless paths of research and engineering endeavor. Exploration of these paths, many of them long and difficult, has no attraction for a manufacturer who is concerned solely with immediate sales. Yet it is through research, backed up by a capable and sympathetic development and application engineering organization, that the real advances are made.

The aim of the RCA Radiotron Laboratory staff is to cover the broad field of electronics in so far as this is humanly possible; to concern themselves equally with research on the fundamentals of tube characteristics and designs, the development of new tubes and the application of existing tubes; to look not only at the immediate present but the near and distant future as well.

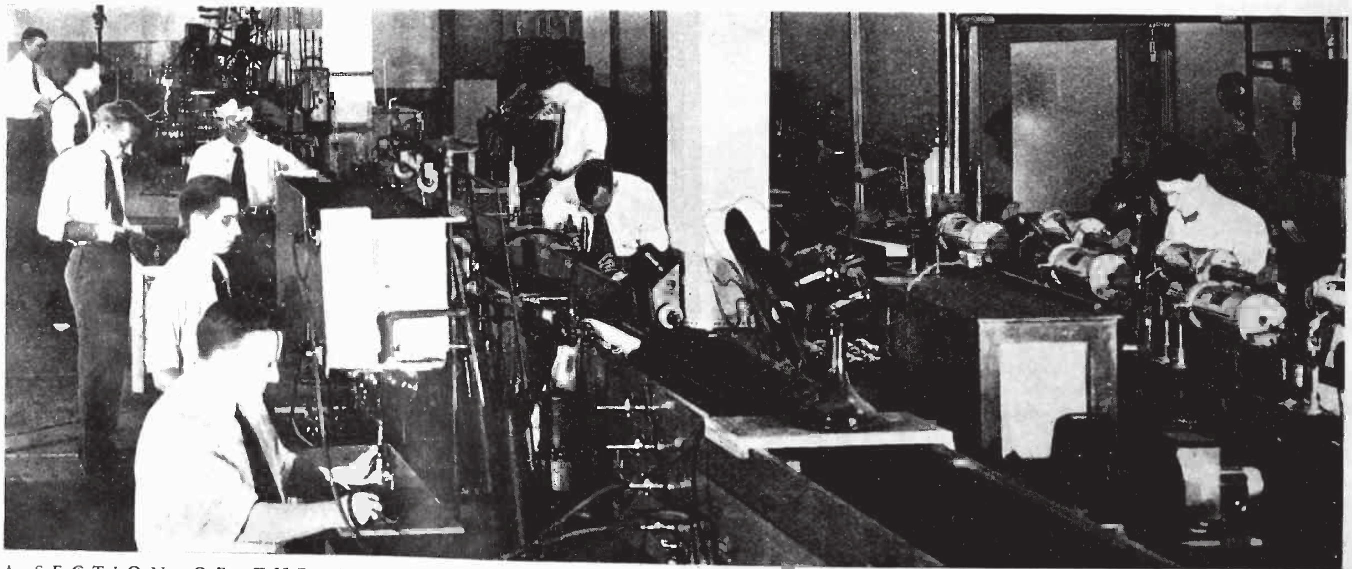
The pursuit of this objective involves a division of laboratory activity into three parts:—research, development and application. While at times, due to the closely related nature of the work, the activities of one section may merge with those of another, the general field of each section remains clearly defined.

The Research Sections

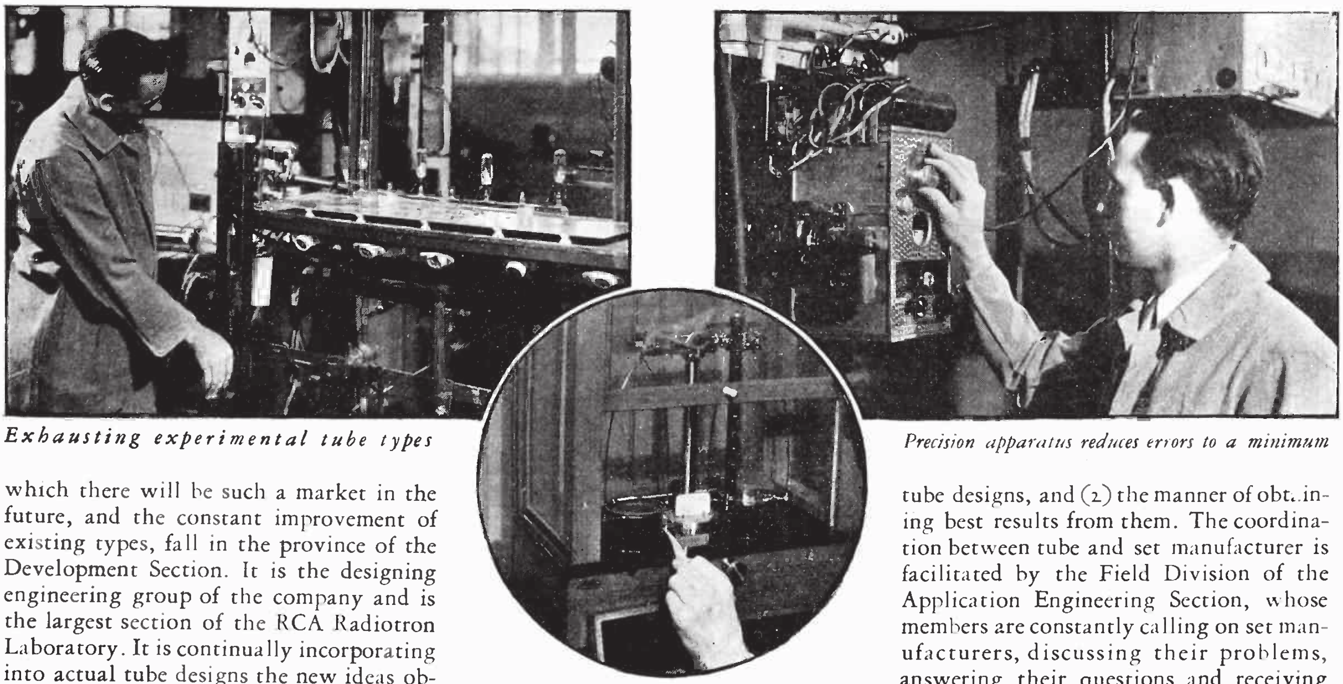
The Research Sections are concerned with new ideas in radio tube characteristics, principles of design, basic materials and processes. Seldom do they occupy themselves with existing tubes, or even the introduction of new tubes of conventional design. Their research activities extend into the field of physical and chemical science. An example of physical research is the recent work on the fundamental principles of tubes for ultra-short waves. The work of the chemical division includes such things as new "getter" substances, ceramics for insulation, alloys for various tube parts, chemical processes and studies of primary and secondary electron emission.

The Development Section

The introduction of RCA Radiotrons and Cunningham Radio Tubes for which there is an immediate practical market, or for



A SECTION OF THE RCA RADIOTRON RESEARCH AND DEVELOPMENT LABORATORY



Exhausting experimental tube types

Extreme care is exercised in all measurements

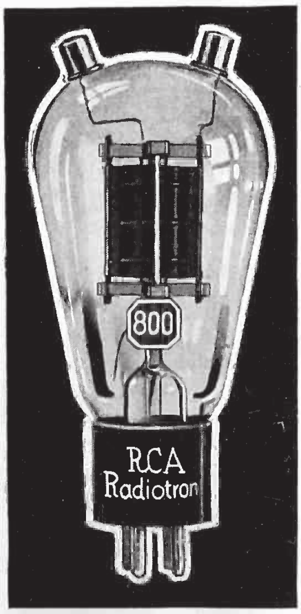
Precision apparatus reduces errors to a minimum

which there will be such a market in the future, and the constant improvement of existing types, fall in the province of the Development Section. It is the designing engineering group of the company and is the largest section of the RCA Radiotron Laboratory. It is continually incorporating into actual tube designs the new ideas obtained from the Research Sections, as well as from its own personnel. In this section a new design is carefully worked out before it goes on to the factory for regular production. Developmental tubes are made in a special factory where the combined experience of engineers and expert factory personnel is applied.

The Application Engineering Section

RCA Radiotron Company, Inc., has long prided itself on its Application Engineering Section. Working closely with "Development," this section acts as a "proving ground" for tubes in process of development. No automobile under development is put through more thorough performance tests on the proving ground than these tubes under actual performance tests in circuits.

Before any new tube is introduced it should be proven that it offers the equipment-design engineers at least two possibilities as compared with tubes already available. These are, to produce a receiver which will give better performance for the same cost, or equal performance for less cost. The two-fold function of this section is, therefore, to find out (1) what can be done with both old and new tube designs, and (2) the manner of obtaining best results from them. The coordination between tube and set manufacturer is facilitated by the Field Division of the Application Engineering Section, whose members are constantly calling on set manufacturers, discussing their problems, answering their questions and receiving their recommendations.



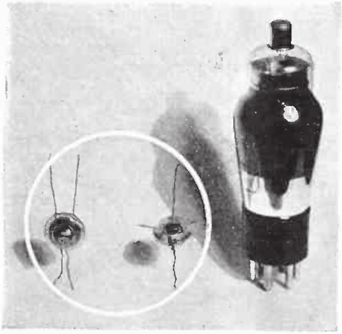
RCA-800—an example of RCA Radiotron Engineering development. The new 800 is designed particularly for short wave transmitting.

Commercial Engineering Section

Another highly important work of the RCA Radiotron Laboratory is the collection, correlation and dissemination of technical data in concise and usable form. This work is performed by the Commercial Engineering Section. The staff of this section, through handling much technical correspondence with users of the product, are fully informed as to the type of data which will be helpful to the technical man. As a result, they are always mindful of his needs and viewpoint when preparing information for distribution.

Testing

The activities of the RCA Radiotron Research and Development Laboratory have been outlined in brief. Numerous essential engineering functions that belong to the laboratory as a whole have not been discussed. Probably the most important of these is the thorough and extensive testing program which is carried on to insure a product of uniformly high quality. The development of the test equipment for measuring both the common and more obscure tube characteristics, careful test procedure, rigid test limits and a consistent life testing program are activities which have been developed to a high degree because of the leading role which testing plays in RCA Radiotron engineering, as it does in RCA Radiotron manufacture.



An example of RCA Radiotron research—a miniature laboratory tube used in research on ultra-short waves.

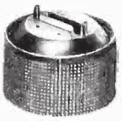
The broad scope of RCA Radiotron research and engineering, plus a manufacturing organization that works hand in hand with it, is responsible for the technical leadership of RCA Radiotrons and Cunningham Radio Tubes.

RCA RADIOTRON CO., INC.

HARRISON · · · · · NEW JERSEY
A Radio Corporation of America Subsidiary

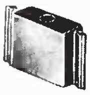
GOAT SERVICE

Inside the Tube — *Outside the Tube*

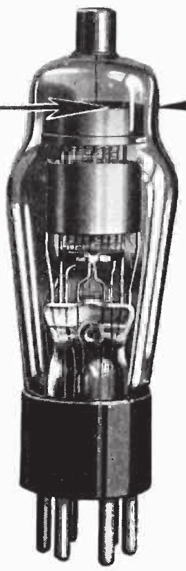

SHIELD

PLATE

COLLAR


DIODE SHIELD

DIODE PLATE



Goat quality parts improve tube performance.

In addition to furnishing a complete range of parts for standard receiving tubes such as these used in 2B7 and 6B7 types, Goat manufactures these parts in unlimited quantities.

All parts are of Goat high standard, and include nickel strip, plain and carbonized, mesh, wire, iron, molybdenum and tantalum.

Facilities are also available for producing special parts for Cathode Ray Rectifiers, Power Tubes, X-Ray Tubes, etc.

Write for further information, samples and engineering data, pertaining to Goat Parts and Service.

Goat form-fitting Tube-shields are revolutionizing tube shielding. They save time and space in chassis design, as well as material and labor.

When Goat Shields are used in place of the old-style "can" shields, tubes can be much closer spaced and still be accessible. The designer is given a free hand in arranging components to suit his requirements and at the same time achieve compactness and simplicity.

Goat Tube-Shields improve appearance and performance. They are available in five types, including new models to fit practically all existing standard receiving tubes.

Cost Sheet savings with GOAT TUBE-SHIELDS

Shields....10% to 25%
Chassis......up to 10%
Cabinet.....up to 10%
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Goat Radio Tube Parts, Inc.
314 DEAN STREET, BROOKLYN, N. Y.

⅙th actual size

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for Radios and Sound Equipment

High fidelity reproduction over the full audio range is economically obtained with the new Model 4A High-Frequency Electrophone. By connecting the Electrophone directly in parallel with your present speaker, projector or reproducer, absolute tone perfection is secured. Simple to install. No additional filters, special networks, field supply or polarizing voltage necessary. Acoustical engineering service available to manufacturers.

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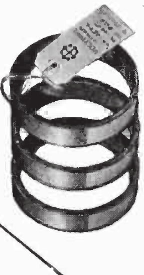
ELMET MOLYBDENUM GRID WIRE

IT MEANS BETTER TUBES!

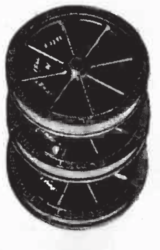


Because - ELMET is truly accurate throughout the extra long lengths in which it is available—we guarantee it.

Because - Due to its unmatched purity and our special methods of manufacture, ELMET discourages Grid Emission.

We control the production of ELMET GRID WIRE from the ore to the finished product and know that it will give you satisfaction.

If you want the best, order ELMET. Send for prices.



AMERICAN ELECTRO METAL CORP.
LEWISTON, MAINE

MOLDED CARBON VOLUME CONTROL

by

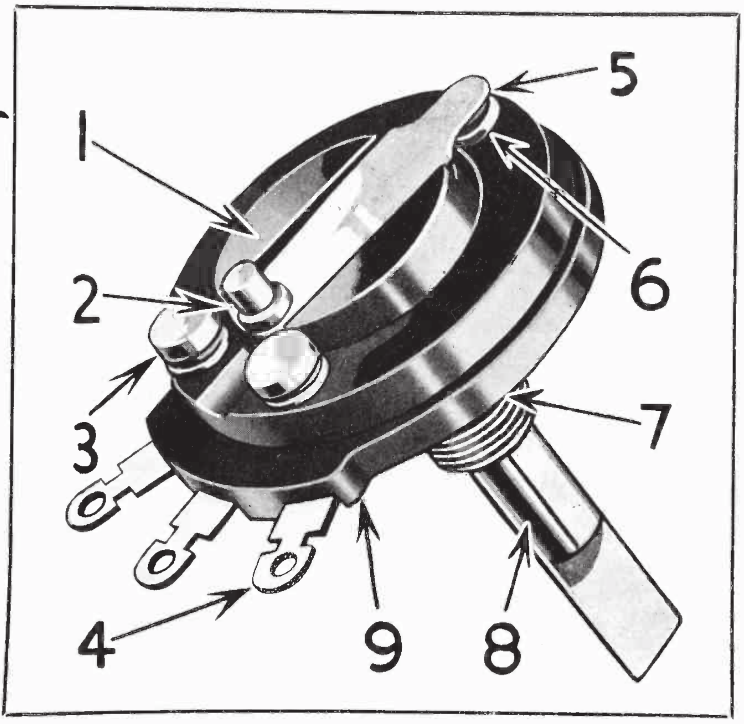
STACKPOLE --

Keeps pace with Radio Progress

9

FEATURES

of design which promote performance



1 Protection offered in fully insulated bushing and shaft

A bakelite hub carries the spring arm and the contact for the moving element. The shaft is molded into the other end of this bakelite hub. Mounting bushing and shaft are thus fully insulated from entire Control Resistor.

2 Accurate switch operation

The cam dog which operates the A.C. switch on switch type variable resistors, is assembled as a composite part of the moving arm member. Accurate switch operation in respect to the resistance curve or hop-off value is assured.

3 Stable and solid assembly

Rugged stop pins are accurately located through the resistor element and the bakelite frame and hold the entire assembly into one solid form.

4 Easy assembly

The lugs of the resistor as well as those on the AC Switch are tin dipped to facilitate the soldering of connecting wires.

5 Smooth action and noiseless
6 operation

A one-piece special tempered spring arm maintains constant spring tension against a nickel chrome, highly polished, non-corrosive sliding shoe. Smooth and easy rotation of the variable resistor arm is assured.

7 Simple mounting

A standard brass bushing for one-hole mounting is fully insulated from the arm and resistor element.

8 Quiet, easy operation

The shaft is of non-rusting cadmium plated steel, perfectly fitted in the bore of the brass bushing to provide smooth and quiet operation.

And

9 *A New, Permanent, Molded Carbon* RESISTOR ELEMENT

Stackpole offers the first control of its type and the first compact variable resistor which is permanent and unaffected by humidity.

The thick molded carbon resistor element, mounted on bakelite frame, is made in much the same way as permanent carbon resistors. Its hard glass-like surface is the result of firing at high temperatures and assures imperviousness to humidity—hard usage and varying temperatures. Stackpole Molded Carbon Volume Controls will carry considerable current, are free from capacity effect, and have low heat and voltage coefficient. They are smooth and quiet in any circuit.

Made in any value from a few hundred ohms to a couple of megohms with any desired resistance taper and any hop off or fixed value of resistance at either or both ends.

STACKPOLE CARBON CO.

ST. MARYS, PA.

Manufacturers of Quality Resistors and Suppressors

Announcing
AmerTran De Luxe Audio Transformers
in
New Mountings
New Designs

All types are available with terminals at top, and those who mount transformers behind a panel will find this arrangement the most convenient.

Where transformers are installed on a chassis and concealed wiring is desirable, base-mounted transformers are necessary. All types can be supplied in this form.

Effective Nov. 1, 1933 AmerTran De Luxe Audio Transformers will be available in new mountings of more attractive appearance, in new designs of greater flexibility. The same high quality which has been maintained for more than 10 years will be built into each unit.

Black crackle finished mountings of similar appearance but varying in size will be used to house all units in our De Luxe Line, including audio, plate, filament, and power transformers, also audio and filter reactors. Terminals are located either at the top or base as specified by the customer.

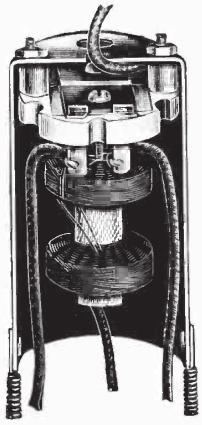
Electrical designs have been revised so as to provide greater flexibility wherever possible without reducing the efficiency. New types are also available for use with new tubes and in latest circuits.

Write for bulletin giving complete information and latest list prices.

American Transformer Company
Transformer builders for over 31 years
178 Emmet St. Newark, N. J.

AMERTRAN TRANSFORMERS

A NEW GEN-RAL
(REGISTERED)
COIL



MCX200 D.V.M.
I.F. UNIT

A double tuned unit for extremely small AC and DC receivers; peaked at an average of 456 K.C. or 175 K.C., and housed in a shield 1½ x 3 in.

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The 1933 GEN-RAL Loose Leaf Catalogue is now ready. Be sure to have a copy in your files.

GENERAL MFG. COMPANY
8066 South Chicago Avenue
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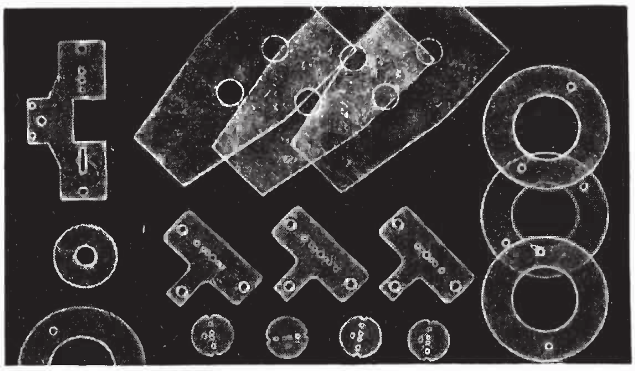

These MICA SHAPES are noted for accuracy

Tube and condenser manufacturers are most enthusiastic about the accurate machining of our mica shapes. They are made of the finest mica obtainable . . . Munsell's India Ruby Mica.

Further details, prices, and samples gladly furnished.

Other Electrical Insulations: more than 120, including "Empire" Varnished Cloths and Tapes, "Lamicoid" Bakelite Laminated and Micanite are described in our new Price Lists. Write for copies.

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in carrying capacity

MIDGETS

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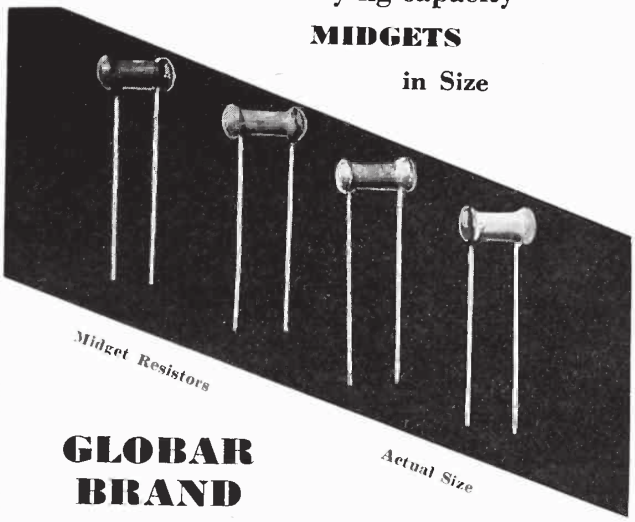

GLOBAR BRAND

Giant-Midget Resistors

Now available, a new series of Globar Resistors—Tom Thumbs in size—Goliaths as carriers.

Glad to send samples and complete information as to sizes, wattages, etc.

GLOBAR CORPORATION
A Subsidiary of The Carborundum Company
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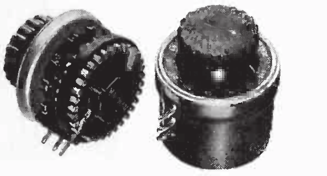
REMLER

NEW LADDER TYPE ATTENUATOR



Designed to meet exacting voice-circuit requirements. Attenuation increased in 53 steps of 3/4 d.b. to 45 decibels. A rising attenuation serves to completely fade the program from 45 d.b. to infinity. Flat characteristic over range of 20 to 20,000 c.p.s. Extremely low noise level. Dimensions 2¼ in. deep by 2⅝ in. wide. Standard impedances, 50, 200 and 500 ohms. Special values on order. LA-5 Ladder Type Attenuator, List Price $18.00

NEW A.C. REMOTE CONTROL BROADCAST AMPLIFIERS

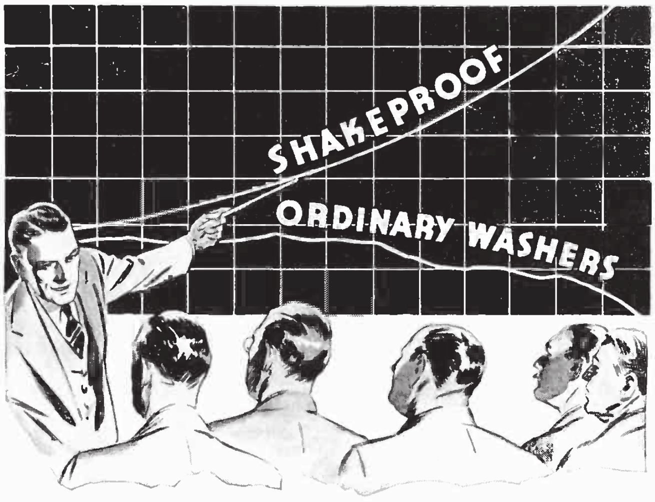
The rapidly increasing demand for these new amplifiers is a tribute to their efficiency. Full A.C. operated including condenser microphone supply. Equipped with level indicator, ladder attenuators, phonograph input, lock type connectors. Adaptable for carbon microphone operation, also for both A.C. and battery operation at slight additional cost. List prices: 1 microphone channel, $245.00; 2 microphone channels, $285.00; three, $325.00; four $365.00. Combination Remote and Public Address Unit, $495.00 List.

Send for illustrated literature.

REMLER COMPANY, Ltd.
2101 Bryant St., San Francisco, Calif.

REMLER—THE RADIO FIRM AS OLD AS RADIO

SHAKEPROOF



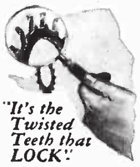
"Vibration Control"

ASSURES SMOOTH

ECONOMICAL PERFORMANCE

THERE'S nothing that destroys efficient performance as quickly as vibration. It strikes at vital connections and, if any nut or screw is unprotected, serious trouble is certain. No product can escape Vibration—but every metal manufacturer can use the Shakeproof principle of "Vibration Control" to keep connections tight. The twisted teeth of Shakeproof Lock Washers bite into both work and nut surfaces—and the greater the vibration the tighter they hold. Let Shakeproof show you how to improve your product and build into it extra years of satisfying, money-saving performance. Write for free testing samples today!

Send today for your free copy of this complete Shakeproof Catalog. Explains thoroughly the many advantages that Shakeproof offers—also shows new patented Shakeproof products.



"It's the Twisted Teeth that LOCK"

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Lock Washer Company

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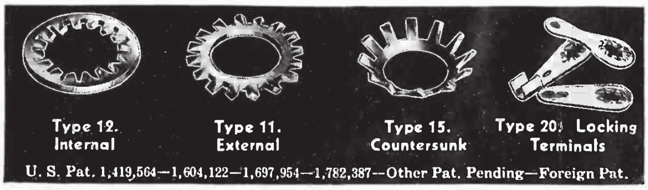

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Our part of the job

Every step in the manufacture of Resinox is toward one goal: to produce a molding material whose quality and uniformity are unexcelled. You can expect consistently good work with material like this.

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KEEP IN TOUCH WITH RESINOX DEVELOPMENTS

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Specify

RESINOX

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CANNON PLUGS

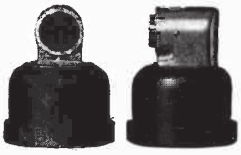
Keep Good Company

MICROPHONES are known by the company they keep. And so is other electrical equipment. The larger manufacturers have found that CANNON Plugs support and make certain the performance of the "built-in" quality of their products. When a manufacturer supplies a "boot-leg" or cheap plug with his equipment, can you trust his equipment?

It will pay you to insist, if necessary, on CANNON Plugs. But almost without exception, you will find that leading manufacturers supply them without insistence.

There Is a CANNON Plug for Every Cable Connector Need

Write for fully illustrated Catalog.



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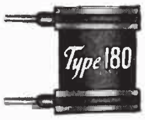
175 Hornby Road, Fort, Bombay, India

SHALLCROSS

WIRE WOUND



RESISTORS

To build accurate testing equipment you must have precision resistors.

Shallcross Wire Wound Resistors are normally calibrated with precision to 1%; they can be furnished to a precision of 1/10 of 1%, if required. Use them wherever precision and permanent accuracy of the resistance is a factor. Bulletin 85 contains electrical and mechanical specifications—send for it.

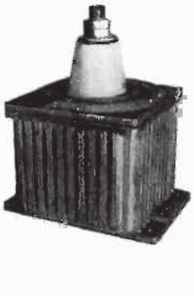
Shallcross Mfg. Company
Collingdale, Pa.

CORNELL-DUBILIER CONDENSERS

Bombarder Capacitors

Cornell-Dubilier announces a new line of Bombarder Capacitors for use with radio-frequency induction heaters and designed for severe service.

THESE CAPACITORS FEATURE:



Rugged mechanical and electrical construction in standard units offered in capacities of .004 to .05 mfd.

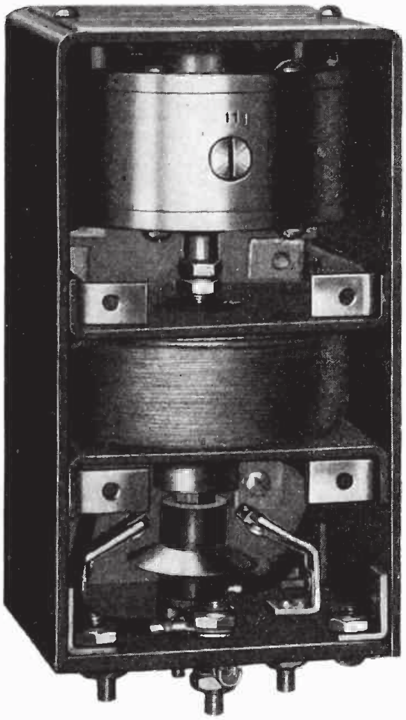
Better cooling and improved internal design, with even distribution of currents, permitting greater KVA capacity in smaller space.

High-voltage-insulated terminal with massive threaded stud and nuts, and mounting feet now placed at base to facilitate mounting and wiring.

Write for technical data on these new C-D Bombarder Capacitors

CORNELL-DUBILIER CORPORATION
4377 Bronx Boulevard - - New York City

AGASTAT . . . . *The Time Delay Relay with Wide Application*



Size 5¼ in. high x 2⅝ in. sq.

Wide Range . . . Adjustable . . . Compact . . . Immediate Recycling . . . Temperature Compensated . . . Pressure Compensated . . . Time Interval Remains Constant . . . Snap Acting Contacts . . . Timing Independent of Voltage Fluctuations.

Types Available

NA-11	Delayed Make After Coil is Energised
NA-12	Delayed Break After Coil is Energised
NA-21	Immediate Make When Coil is Energised Delayed Break After Coil is De-Energised
NA-22	Immediate Break When Coil is Energised Delayed Make After Coil is De-Energised

Infinite variations of timing effects possible by circuit combinations of above types.

Write for Bulletin with Technical Details, Application and Design Information

AMERICAN GAS ACCUMULATOR COMPANY
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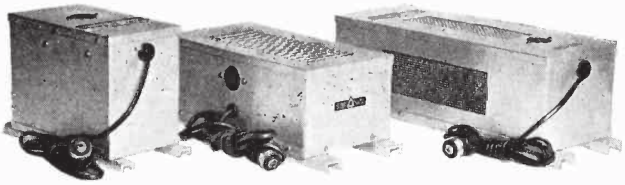

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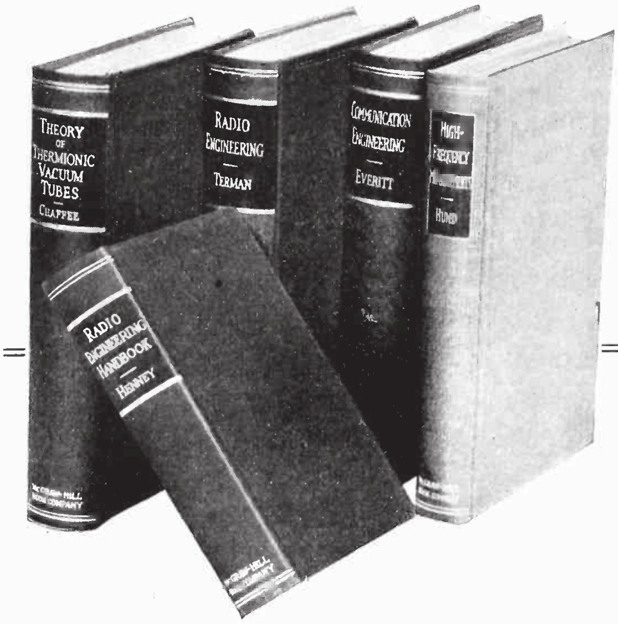
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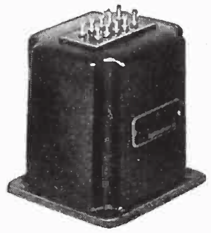

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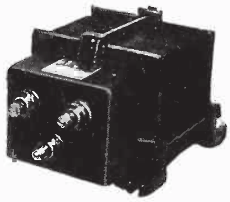

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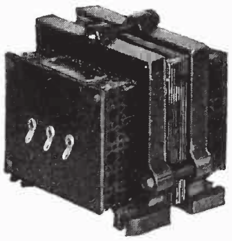

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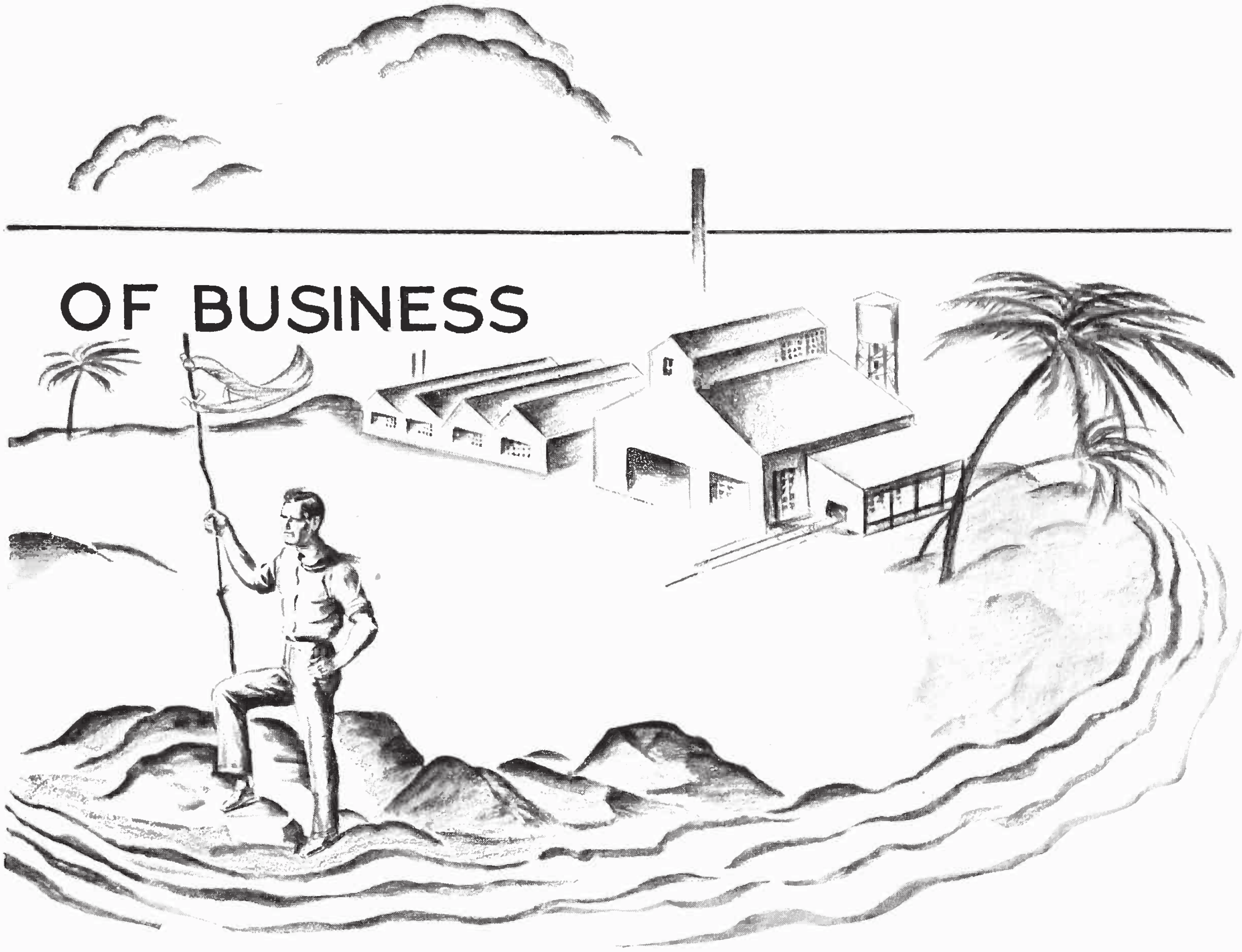

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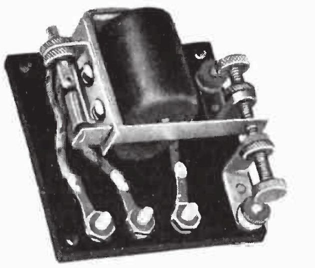

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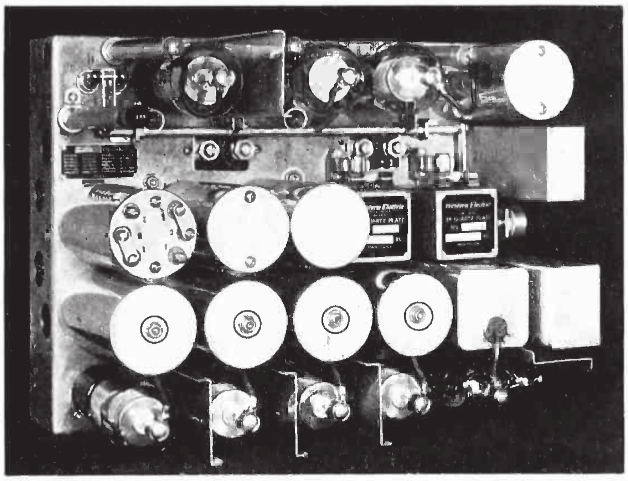

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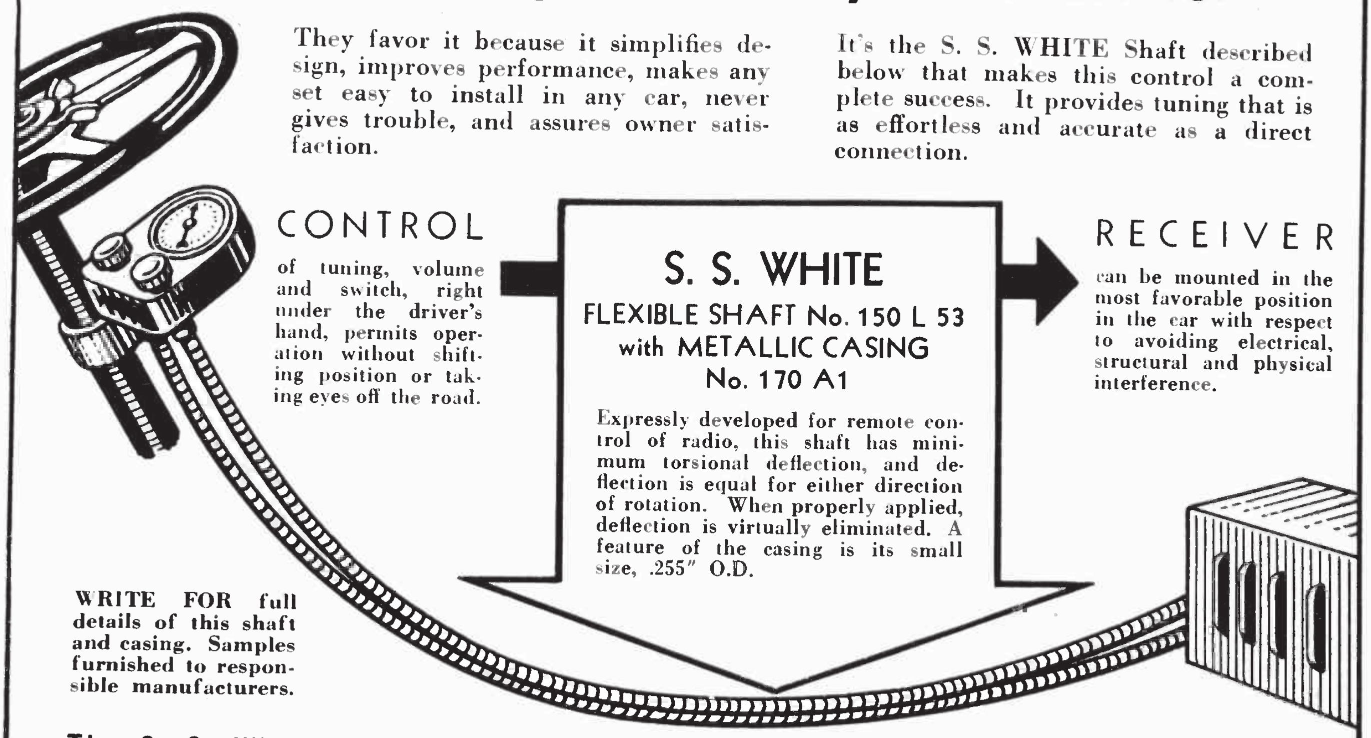

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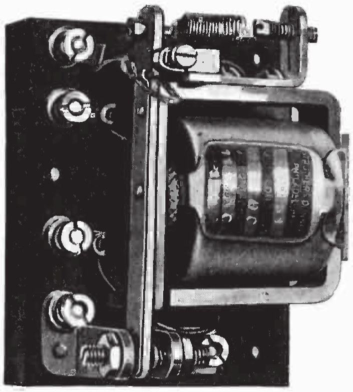

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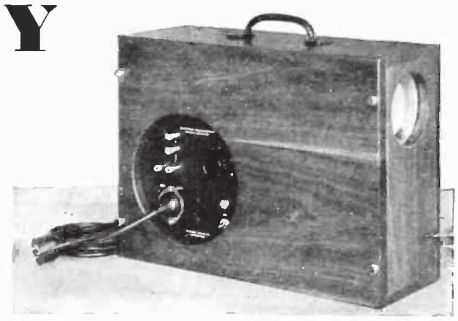

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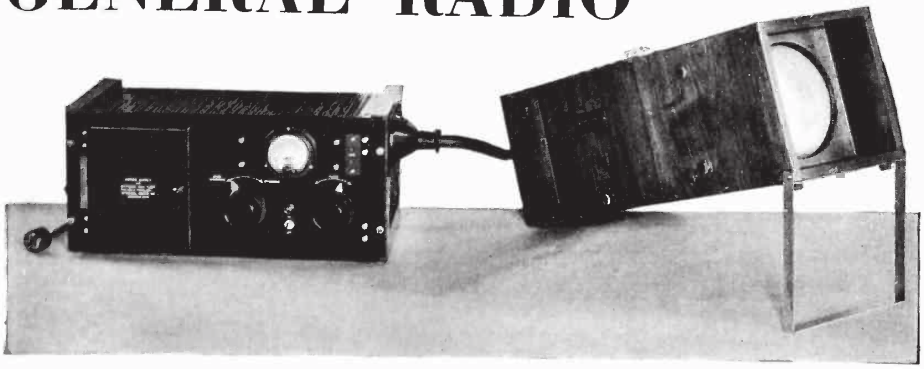

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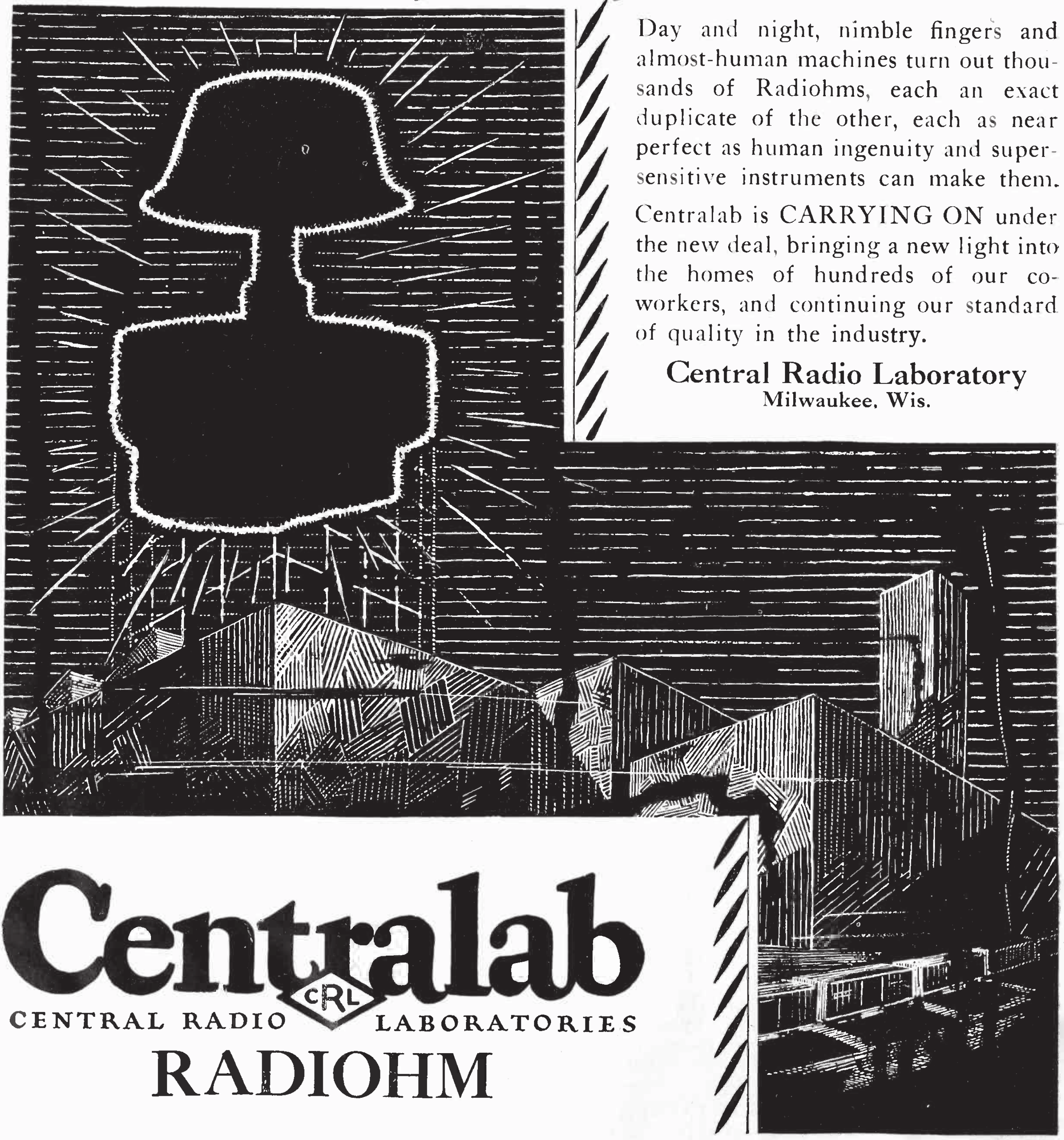

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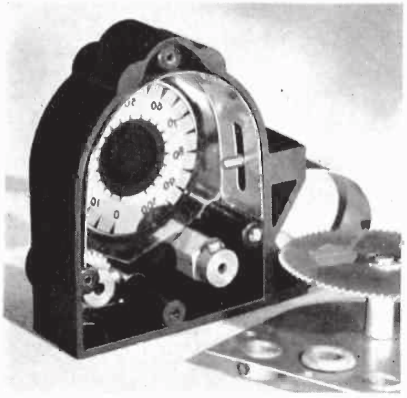

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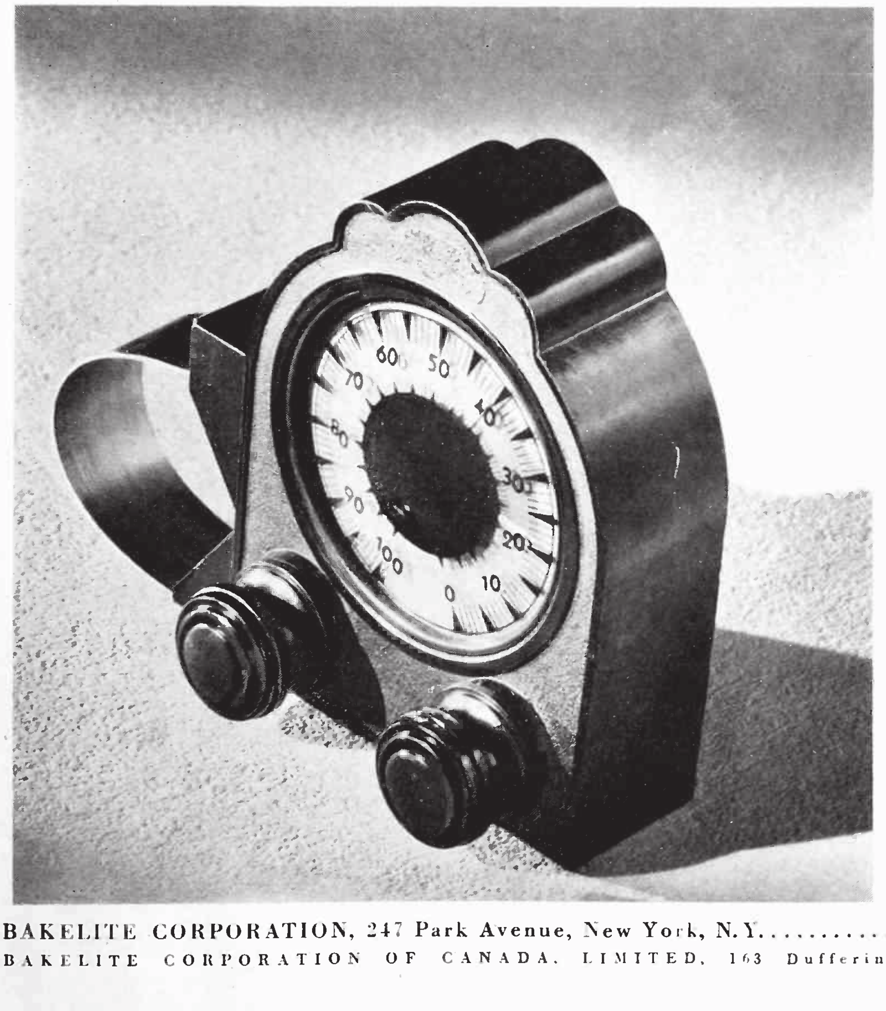

Photos show Falck Remote Control with Bakelite Molded housing & knobs. Product of Advance Electric Co., Los Angeles, Cal.

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◆

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◆

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◆

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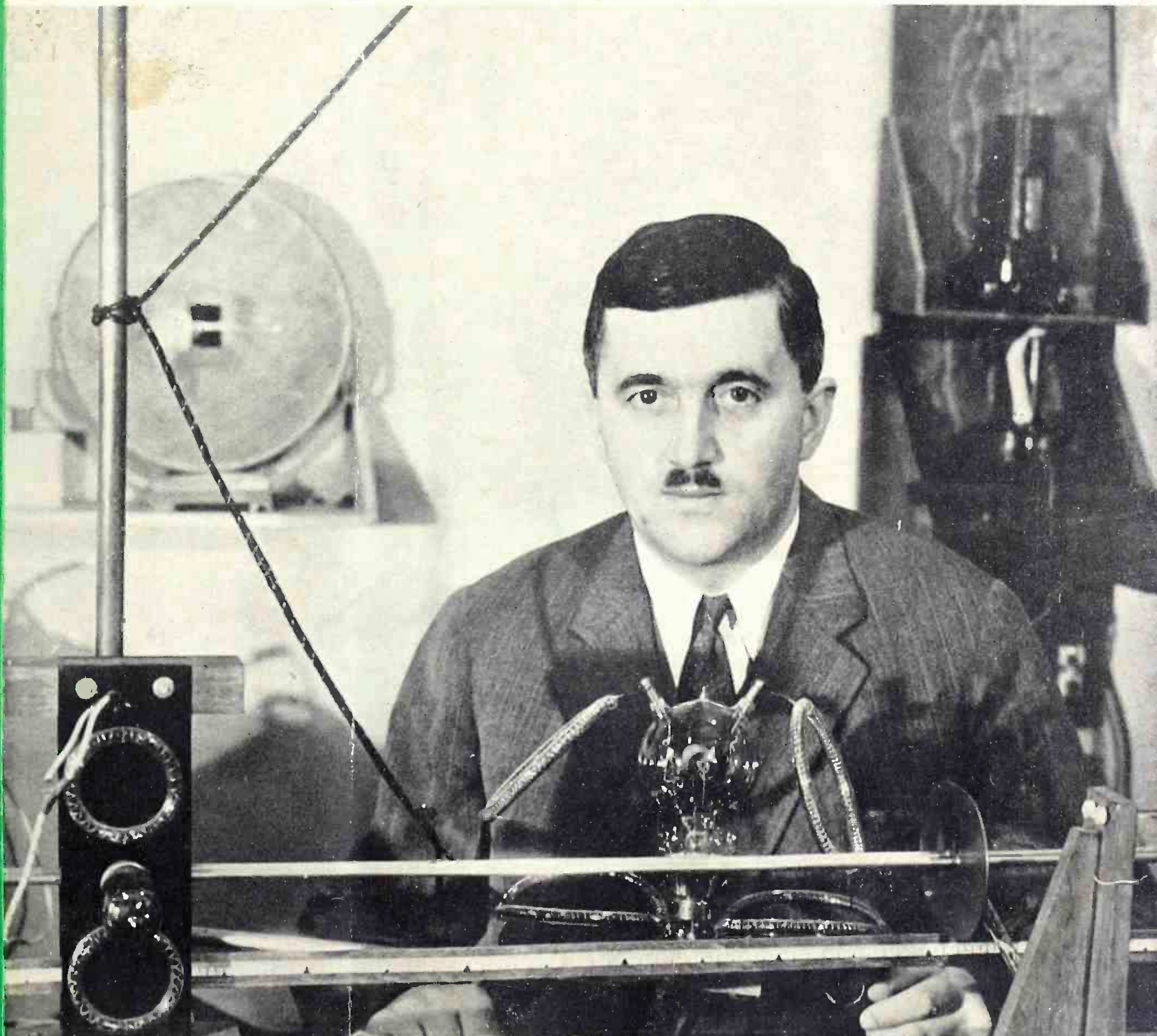
◆

At right—3-cm. waves at California Tech.

See page 316



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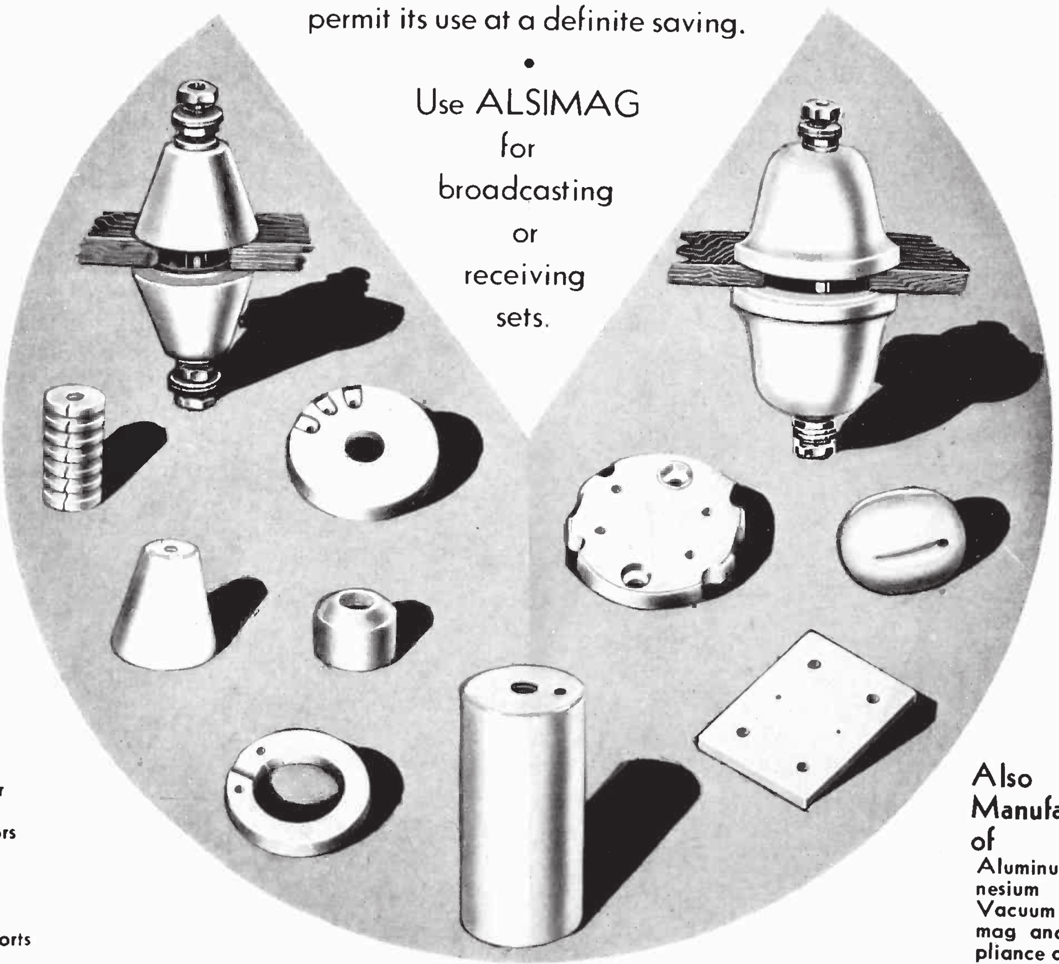

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ELECTRONICS, November, 1933. Vol. 6, No. 11. Published monthly, price 35c. a copy. Subscription rates—United States, Mexico, and Central and South American countries, $3.00 a year. Canada, including duty, $3.50 a year. All other countries, $4.00 a year or 20 shillings. Entered as second class matter April 4, 1930, at Post Office at New York, N. Y., under the Act of March 3rd, 1879. Printed in U. S. A. Cable address "McGrawhill, New York." Member of A.B.P. Member of A.B.C. Copyright 1933 by McGraw-Hill Publishing Co., Inc., 330 West 42d Street, New York, N. Y.

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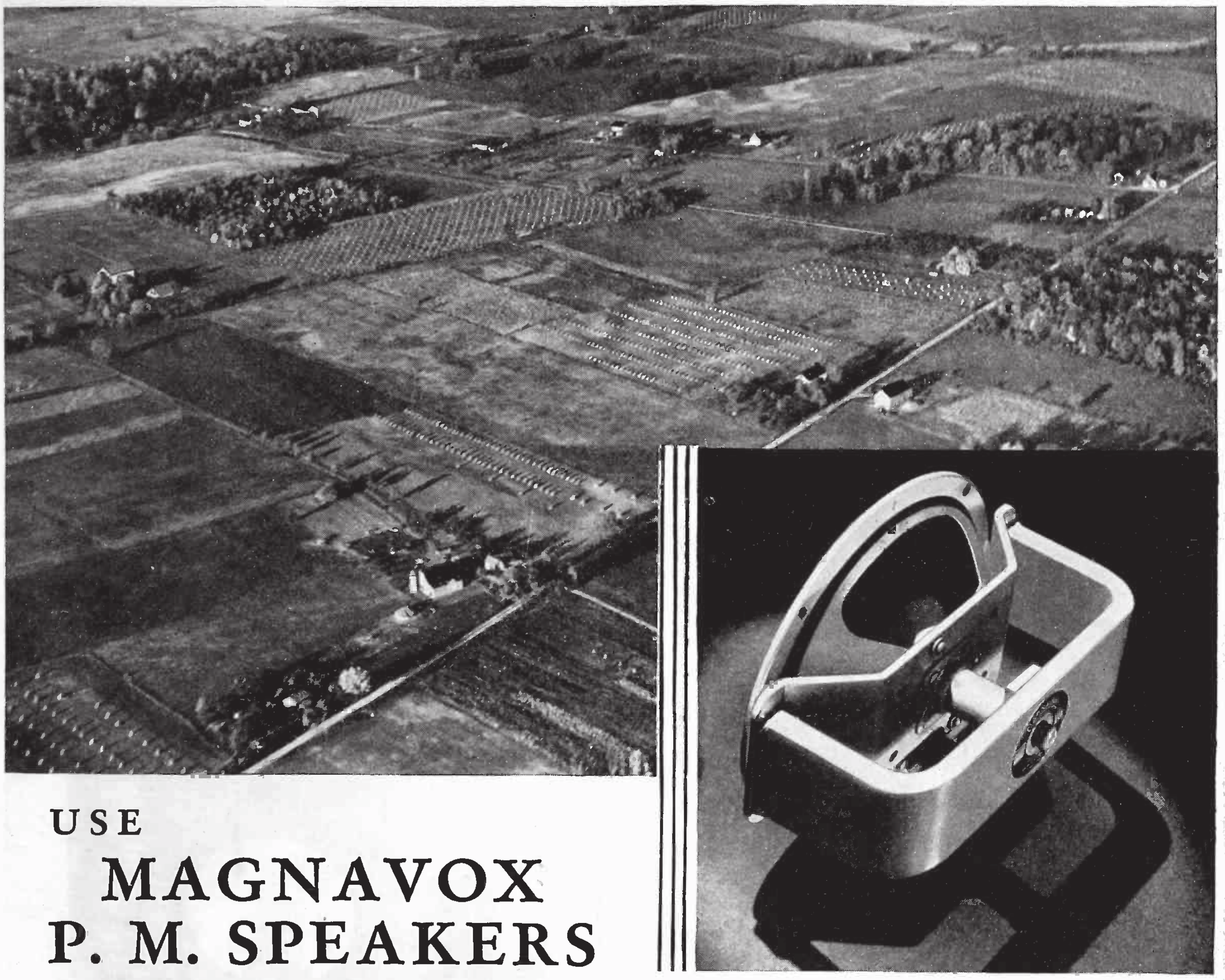
IN THIS GREAT MARKET FOR BATTERY RADIO



This Magnavox Permanent Magnet Speaker makes possible the development of the great farm market because it provides dynamic performance for battery operated radio sets.

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for Dynamic Performance

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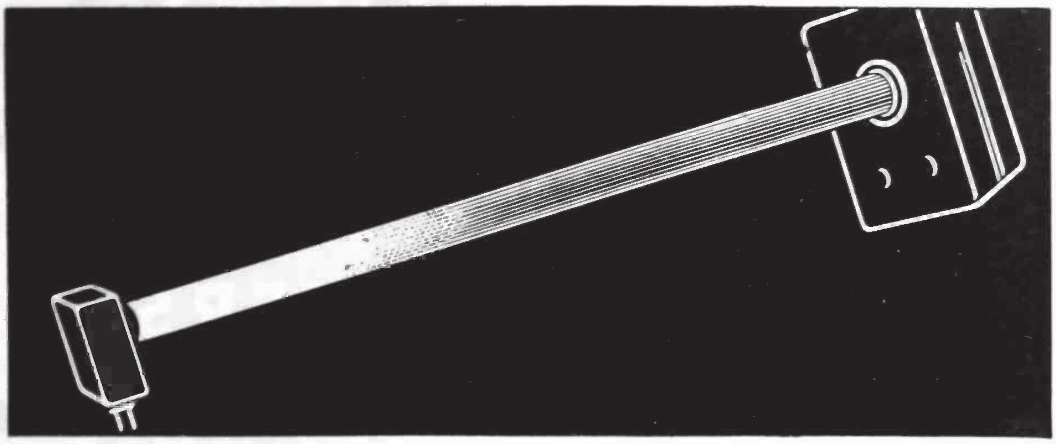

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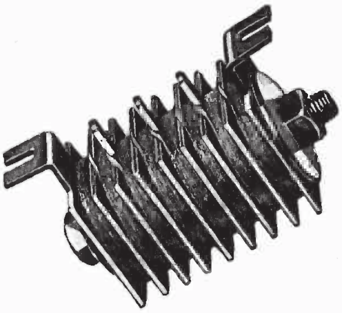
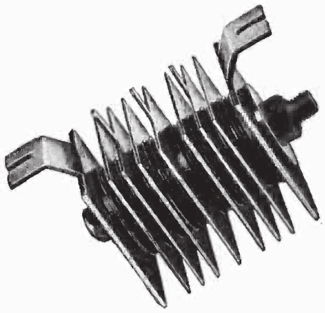
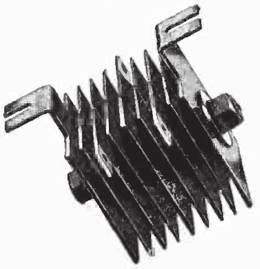
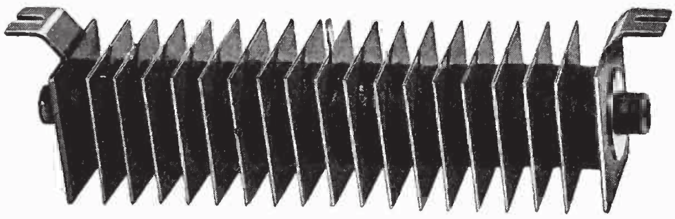
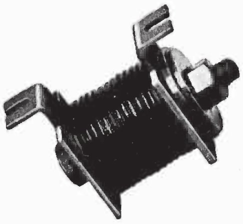


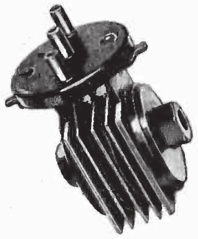
MALLORY DRY DISC RECTIFIERS











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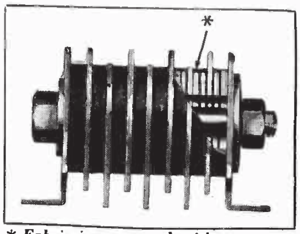

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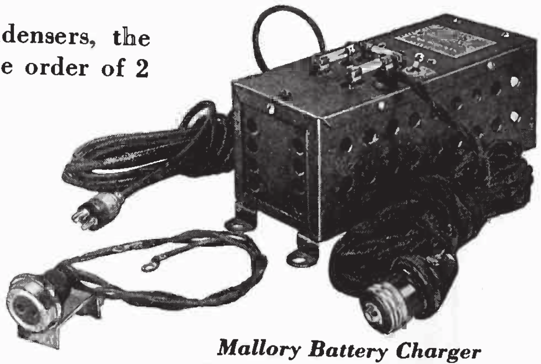

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New York, November, 1933

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telephony
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grading
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beam transmission
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amplifiers
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traffic control
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beacons
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automatic processing
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▼

Steadying radio parts production

THE past few weeks have witnessed a surprising turn in the tables, in the radio industry.

Only a little while ago, the parts manufacturers and parts suppliers were wringing their hands, seeking buyers for their products.

Then with Indian summer, came the sudden demand for radio sets from the public. Set manufacturers' stockrooms were soon bare; their supplies of parts and raw materials were overnight exhausted. The parts makers found themselves in a seller's market, but with demands for goods far outrunning any possibility of supply.

* * *

THIS experience, topping all the other jolts of the economic whirligig of radio, has cost both sides real money, and must be enlightening to both sides. Both the parts suppliers and the set makers should come to realize how they depend upon each other. It would seem to be the essence of good industry planning to set up some intergroup basis of production which will keep both groups busy and prosperous. The world as a whole is now beginning to learn that forced idleness and localized prosperity cannot go along together.

The old opportunism of "feast or famine" will have to be eliminated from radio, also. It is time the parts producers and the set makers sat down together and figured out the basis for a sound, steady-going radio-set production.

THIS NEW RADIO

Is it sound? Will it last? Can the NRA NEMA-RMA Code supervisors effect stabilization of radio industry?

THE whole radio industry has been enjoying sudden prosperity.

Set manufacturers have fallen far behind in their orders, and have been working their plants overtime.

Parts manufacturers in some cases have had to go on double and triple shifts. One plant has multiplied its payroll employees by six times, as compared with the number employed a year ago at this period.

Even for the radio engineer, the employment stringency has lightened somewhat, as manufacturers are building back their organizations, particularly on the production side.

There is no doubt about it, that for the present, at least, the whole radio production industry is bathed in the warm sunshine of prosperity and customer orders. Manufacturing activity is feverish, and once again the lights burn in radio plants long into the night.

But will it last?

But is all this demand for radio sets and radio parts to be regarded as permanent? Will this unique revival of past prosperity last beyond the next month or two? Will manufacturing plants be speeded up and output multiplied, only to build up a tremendous overstock, which eventually will have to be liquidated, at tremendous losses, with "dumping" and destruction to retail businesses? Will January and February see a return of the disastrous practices of a few years ago?

There is plenty of evidence to be had that the radio industry is already accelerated to a pretty excessive pace. Surveys of retail dealers indicate that these front lines of radio selling have not felt the new sunshine and "new deal" in such poignant fullness as have the manufacturers who are shipping them the goods. The dealers' stocks have been sadly depleted this past year, and so they are just beginning to be replenished. These stocks are being built up, and customers are buying some sets and taking them away. But the time at which the slack is going to be absorbed, and equilibrium established, will depend upon a lot of external factors, beyond the control of radio. The advance of farm price-levels, the further restoration of industrial employment, the release of money from closed banks, are all conditions which can extend and protract the rate of consumer buying of radio sets, possibly even into a permanently prosperous activity for the whole radio industry.

The new factor of industry control

But another new element that can make for stability of the radio industry has come into the 1933 picture, a force that was not available in previous periods of radio optimism. Now, thanks to the new Administration at Washington and to General Johnson and the NRA, supervisory agencies have been set up for radio as well as for other manufacturing groups, and between these Supervisors and NRA headquarters there will be available full and immediate knowledge of employment enrollment, set prices, and inferentially, set production.

Arthur T. Murray, of Springfield, Mass., chairman of the radio-set division of the Radio Manufacturers Association, is Supervisory Agent for radio-set makers under the NEMA Electrical Code, which was accepted by the radio manufacturers. Leslie F. Muter, Chicago, chairman of the parts division RMA, is Supervisory Agent with jurisdiction over parts, cabinets and accessories. The radio-tube makers, who joined the National Electrical Manufacturers Association directly, as individual members, with their own section, have chosen as tube supervisors a committee made up of E. T. Cunningham, B. G. Erskine, and H. W. Harper.

Supervisory agencies administrating radio under NEMA-RMA NRA Code

ARTHUR T. MURRAY,
United American Bosch,
Springfield, Mass.
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LESLIE F. MUTER,
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Tubes

B. G. ERSKINE,
Hygrade-Sylvania,
Emporium, Pa.
Tubes

The radio-tube industry, represented by a special section of the NEMA, is supervised by a committee comprising Messrs. Cunningham, Erskine, and Harvey W. Harper, Tungsol Radio Tubes, Inc., Newark, N. J.

PROSPERITY—

Receiver, parts and tube manufacturers are busy. Retail dealers not so sure of continuance of public demand

Supervisor Murray is initiating in radio the "open price" provisions of the NRA-NEMA Electrical Code, and has already required the filing by radio manufacturers of their net sales prices or their list prices, with maximum discounts, and terms of payment. This will apply to all types of radio receiving sets. These prices and discounts will then be made known by Mr. Murray's office to all competitors producing similar items.

This "open price" plan is regarded as an important step toward market stabilization and toward the disappearance of unfair and undesirable practices in radio set manufacturing. Set makers will be required to adhere to their officially filed prices and discounts, and to advise the supervisory agency of any changes. In addition to the price reports, three labor reports are being asked for, by the supervisors, to be transmitted to NEMA headquarters and Washington. These will give complete statistical information regarding seasonal peak overtime employment, labor employed in emergencies, and adjustment of wage rates under the NRA Code. Such labor reports will be required monthly by the supervisory agencies.

Thus the offices of the NRA authorities become centers of all basic information relating to the production of radio sets. It is apparent then, that the NRA Code machinery provides the means for applying the brakes against the radio industry again "running away with itself" as has happened in previous periods of prosperity.

Set and parts manufacturers busy

But the increased production schedules and increased numbers of workers and payrolls, throughout the radio industry give very tangible evidence that a sudden new demand for radio productions has come all along the line.

One large manufacturer of nationally known sets is understood to be able to deliver hardly one in ten of the sets ordered for Christmas business. Inability to get raw materials and parts, has held up his production in the face of overwhelming orders. Other set people have found that their shipments are falling far behind the requirements of their distributors.

Upon the parts suppliers came a sudden and unexpected demand that has overtaxed their depleted facilities, following upon a long period of sales at prices dictated by chiselers and price cutters, with production cut to almost nothing.

But the parts people have met the new demands with surprising facility, and have speeded up their plants, restored employment, added extra shifts, and kept production pouring out. The Summerill tubing plant, for instance, has increased its payroll 570 per cent, compared with a year ago, while the number of workers is sixfold. With three shifts, production is unbroken 24 hours a day!

In an effort to find out conditions in the local distribution of radio sets and tubes, the editors of *Electronics* and *Radio Retailing* collaborated in a survey of jobbers and dealers throughout the United States, requesting telegraphic replies indicating whether consumer buying at this season is exceptional, and whether present activity may be looked to continue.

Responses indicate that while in some sections, like New England, there is very real demand from the public, yet in other districts like the Middle West, extensive customer sales still wait on increases in the prices of hogs and farm products. In other communities which suffered most from the bank closings of last Spring, active radio purchasing is expected as soon as the government thaws out the frozen assets and releases a substantial proportion of the depositors' funds.

Here are replies from the front-line trenches of radio selling:

OHIO—October demand much less than in September. November outlook not as good as last year, unless entire change can be effected by administration and fear of higher prices again be instilled into public. Would caution manufacturers against overstock, as we don't want dumping in January this season.

IOWA—Believe there is greater consumer interest in radio this year. Consumer buying has declined past month, on account of the decline in farm prices. Believe that if hog and corn prices advance materially will have much better business for November than last year. Certainly until dealers begin to accumulate inventory, they can't move to consumers.

MICHIGAN—Too much price rise since September 1. Over-production may result, as rural buying is very light due to low price of farm products. Too much price differential on competitive lines. Radio here had a spurt the first of October, dull latter part. November outlook about same as last year, due to strikes in cities and rural attitude.

ALABAMA—Retail orders for radio placed fifty-fifty for stock and customers. Expect hundred per cent increase this year. Believe manufacturers should be cautioned as over-production will cause dumping.

NEW JERSEY—Will need all factories can make. We are waiting for banks to open for record business. Urge avoid multi-prong tubes and tuning meters in sets as much as possible.

WISCONSIN—Requirements being bought mostly for stock. Consumers not buying high-priced radios as yet. Outlook for November not so rosy. Look forward to less business this year. Manufacturers should be cautioned not to go wild on price increases nor on production, as lull will follow stock requirements.

LOUISIANA—Fifty per cent of our orders are for immediate requirements. The future looks 25 per cent better than last year. Urge that manufacturers not overproduce.

CONNECTICUT—Strong public demand for radio sets here. Believe most Massachusetts and Connecticut dealers way behind orders. General business much improved.

Iron core intermediate frequency transformers

By ALFRED CROSSLEY

Consulting Engineer

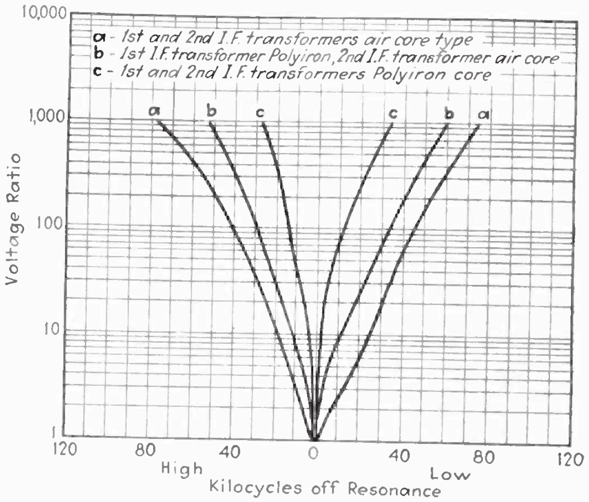
THE use of iron cores in radio frequency transformers is old, but recently a radical improvement has been made in such transformer design, in the interest of obtaining higher gain and greater selectivity. These features greatly surpass those obtained in the past with iron core systems, and in their present state, the new transformers or tuning systems are superior to air core systems.

During the period from 1919 to 1926, iron was employed in radio frequency transformers for the purpose of obtaining a flat amplification characteristic over a broad band of frequencies. The introduction of the iron into the radio frequency field introduced losses, and reduced to a minimum the selectivity of the transformer, and to a marked degree the gain. In other words, iron was used as a means for broadening the selectivity characteristics of the transformers, and in addition eliminating the tendency toward self-oscillation in circuits, due to additional load placed on the tube circuit by the insertion of the iron in the radio frequency field.

The original application of iron in transformer design in this country comprised a development of four broad-band transformers covering selective ranges from fifteen to fifteen hundred kilocycles. These transformers were housed in one unit, and resort was made to the use of a switching arrangement to change from one transformer to another. The results were applied later commercially by such companies as General Electric, Remler, Murad, and other companies in their tuned radio frequency receivers, and later, the early model superheterodynes.

In these receivers, one and one-half mil silicon steel, or its equivalent, with a heavy coating of enamel was employed, and reliable operation was obtained over the broad band of frequencies necessary to cover the broadcast band. The advent of the superheterodyne receiver, which required a definite intermediate frequency soon indicated that the iron core type of transformer was not satisfactory from a gain and selectivity standpoint, and this type of transformer was abandoned in favor of the air core transformer, which showed greater gain and selectivity for a specified frequency. It is to be noted that the iron core transformers used in these early superheterodyne receivers were not designed to resonate at frequencies higher than sixty kilocycles.

In 1931, there was brought to the attention of commercial radio engineers the fact that iron cores were again being considered in radio frequency tuning circuits. W. J. Polydoroff, of the Johnson Laboratories, Chicago, had developed a new type of iron core employing finely divided iron, assembled in a special core form, the particles being insulated one from another by the use of suitable plastics. Polydoroff's work was confined to the broadcast band, and he definitely proved that this material could produce better results from a gain and selectivity standpoint, than that of air core tuning devices in the same frequency range. This work is very completely covered in Mr. Polydoroff's paper in the *Proceedings of The Institute of Radio Engineers* for May, 1933. (See also *Electronics*, July, 1931, "Tuning by permeability variation," Ralph H. Langley.)



Effect of using iron core in 456 kc. a.c.-d.c. receiver with composite oscillator, single i-f stage and diode a.v.c.

It is the object of this article to describe certain phases of the application of the special iron developed by Polydoroff to intermediate frequency transformer design.

Use of iron in intermediate transformers

The development of intermediate frequency transformers first has to be considered from a coil design standpoint, and secondly from an iron content standpoint. Various forms of coils were tested. These coils were of the cylindrical, toroid, bank wound, and Universal type of winding. Of these various types, the Universal type of coil was found to be most efficient, and also the most economical. It has less distributed capacity, and greater inductance per foot of wire than any other type known. In view of the coil design, it became necessary to change the iron core features from the conventional iron enclosed type to that of the open end cylindrical type. The coil is wound directly on the core, and an optimum coil form size has been developed, which is a compromise between distributed capacity, and iron core dimensions. An ideal coil form, having minimum distributed capacity is best from an air core standpoint, but when we desire to take advantages of the iron core, it is necessary to have the turns closer to the iron core, thus reducing the amount of copper used in the coil, and in view of this fact, a compromise must be made in the coil design.

Due to the peculiar and intense field produced by the primary and secondary iron core tuning units and also due to their low resistance, it was found that optimum coupling from a magnetic standpoint required considerable separation between the units. This did not produce a practical type of transformer, and in the interest of compactness, and with no loss in gain or selectivity, a special construction was employed in which the tuning units were placed in such a position that their magnetic fields were nearly at right angles to each other. This construction is worthy of mention in view of the fact that the coupling can be either magnetic or magnetic and capacitive, by movement of one coil to either side of the zero coupling position. It was found, however, that the introduction of magnetic coupling was detrimental, in view of the fact that the stray capacitive coupling produced a condition of over-coupling, and for best results, it was necessary to introduce a counter-magnetic coupling, in order to reduce the total coupling to a condition of optimum or less than optimum, for best transformer efficiency.

Comparative measurements on efficiency of air and iron core transformers were made by employing a standard stage-gain setup. This consisted of a type 78 pentode r-f amplifier stage feeding a type 77 detector with a type 41 audio output tube. The transformer to be tested was interposed between the plate of the 78 tube and the grid of the 77 detector tube. This setup simulates actual practice inasmuch as we are interested only in gain versus selectivity. Information on the Q of transformers is of value, and was obtained by other methods, but in the final analysis, we are primarily interested in gain versus selectivity, and, therefore, these latter values will be quoted in this paper.

To express in a simple way the efficiency of the new type of transformer, it is convenient to use a "figure of merit," taken as the product of the stage gain, or amplification obtained by the transformer, and the ratio of the input at ten kilocycles off resonance to that obtained at resonance. In other words, if the transformer had a gain of three hundred, and a ratio of five between ten kilocycles off resonance and resonance, then the "figure of merit" is 1500. Working from this standpoint, it may be stated that measurements on a good air core type of transformer in a ½ in. aluminum can, similar dimensions to that employed in the iron core transformer, has a figure of merit of 1260. The gain obtained with the air core transformer is 200, while the selectivity ratio is 6.3. The iron core transformer showed a gain of 282, with a selectivity ratio of 11.7, or a figure of merit of 3300. Both transformers were adjusted to have identical inductance in order that the comparison would be valid. These data cover results obtained with a 456 kilocycle transformer, having an inductance of 1.5 millihenrys. This value is close to that employed in the present day superheterodyne receivers.

The effect of the can or metal container on the figure of merit of iron core transformers is very marked, more so than in the case of air core transformers. An increase in can diameter from 1½ inches to 2¾ inches diameter increases the figure of merit from 3300 to 4800, while if the transformer is removed from the container, the figure of merit increases to 5180. These data were obtained with containers averaging 4 inches in length, and the shielding of the transformer was completed by proper fastening to a metal base plate.

Measurements conducted at various intermediate frequencies indicate conservatively that the iron core transformer can be designed to produce either double the gain or double the selectivity obtainable with the better type air core transformers of today. This figure can be improved upon, as the frequency requirement of the transformer is decreased. When we consider that the gain obtained in a radio frequency amplifier is a square law function, it can be readily noted the substitution of iron core in place of air core transformers in a receiver employing two tuned stages, the gain is quadrupled for equal selectivity. A check on this condition in practice was made on a commercial five-tube superheterodyne, which with air core transformers had a sensitivity of 100 microvolts, and a band width of 120 kilocycles, at one thousand to one ratio, at one thousand kilocycles. When the two air core intermediate frequency transformers were replaced by the iron core type, the receiver showed a sensitivity of 24 microvolts, with a selectivity of 41 kilocycles.

The iron core type of intermediate frequency transformer has shown such marked superiority over the air core type, that it seems to be only a matter of time before this type of transformer will be accepted commercially in the interest of greater selectivity or reduction in the number of tubes employed. The iron core having many times the permeability of air, and low losses, permits a large reduction in copper or turns with the consequent all-around improvement of transformer or tuning unit efficiency. This condition is obtained at frequencies as high as fifteen hundred kilocycles, and when used at lower frequencies, the saving in copper and the increase in efficiency becomes increasingly marked. The capacitive type of coupling for transformers produces equivalent results to that of the magnetic type, but is more economical, due to the smaller space required, and the less expensive mounting form.

The writer wishes to express his appreciation for assistance in the investigation to H. E. Meinema and C. C. Neighbors.

AIR CORE VERSUS IRON CORE I. F. TRANSFORMERS

(456 Kc.)

Type	1	2	3	4	5	6	7	8*
Air core.........	500	200	1900	4400	3.8	8.8	6.3	1260
Iron core........1	400	250	4000	6900	10.00	17.25	13.63	3410
" " 2	385	260	3800	6450	9.88	16.75	13.32	3470
" " 3	370	271	3400	5750	9.2	15.50	12.35	3350
" " 4	380	263	3800	5850	10.0	15.40	12.70	3340
" " 5	400	250	4300	6500	10.75	16.25	13.50	3380
" " 6	365	274	3250	5800	8.9	15.9	12.40	3400
" " 7	380	263	3700	6100	9.73	16.0	12.86	3380

*1. Microvolts at resonance.
2. Gain.
3. Microvolts at plus 10kc.
4. Microvolts at minus 10kc.
5. Ratio microvolts resonance versus plus 10kc.
6. Microvolts resonance versus minus 10kc.
7. Average ratio.
8. Figure of merit.

EFFECT OF CONTAINER

Aluminum—4 inches high

Container diameter	Gain	Selectivity Ratio	Figure of merit
1½	143	16.18	2318
1⅝	159	18.17	2890
1¾	167	20.07	3340
2	185	18.75	3470
2⅛	204	20.05	4008
2½	238	17.97	4280
2¾	247	19.40	4800
In Air	290	17.85	5180

Photoelectric control on packaging machines

By E. LOVELL SMITH

Package Machinery Company,
Springfield, Mass.

In many applications of photoelectric control to automatic machinery, the control supplies an impulse that initiates or performs a particular operation. If only a momentary impulse is required from the cell, the speed of response usually imposes restriction in the selection of the photocell and its amplifier and relay. An example of such an application is found in packaging or wrapping machinery for applying wrappers of printed cellophane to cigars, candy bars or packages of chewing gum. The roll of cellophane is printed with the design properly spaced to provide the right length of wrapper for one package.

In each cycle of operation the machines feed a length of paper, cut it off, and wrap it around a package. Thus, the paper feed is intermittent, and the position of the printing on the wrapped article depends on the position of the printing in relation to the cutter. This relation must be corrected constantly when the machine is running, because of the effect of variation in temperature and humidity on the cellophane strip. When a manual control on an adjustable paper feed mechanism is used, the full time of an operator is required to keep the paper in register, and corrections can be made only after a properly wrapped package has been delivered by the machine.

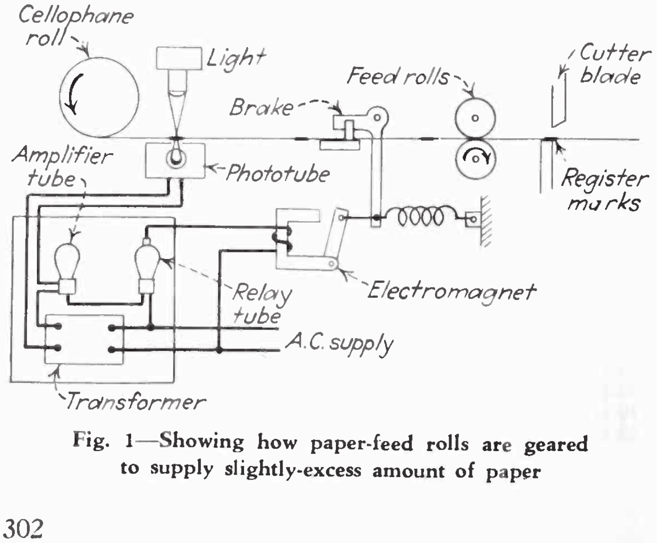


Fig. 1—Showing how paper-feed rolls are geared to supply slightly-excess amount of paper

In a wrapping machine developed by the Package Machinery Company, illustrated in Fig. 1, the paper feed rolls are geared to supply slightly more than the required length of paper. A clapper-type magnetic brake, released by the photo-cell, as shown in the diagram Fig. 2, stops the paper at the proper point. A cam operated by the machine then releases the brake for the next cycle of operation. To obtain more accurate timing of the operation of the brake, mechanical relays are placed by a grid control, rectifier or relay tube, and to match the speed of the relay tube it is necessary to use the photo-emissive cell.

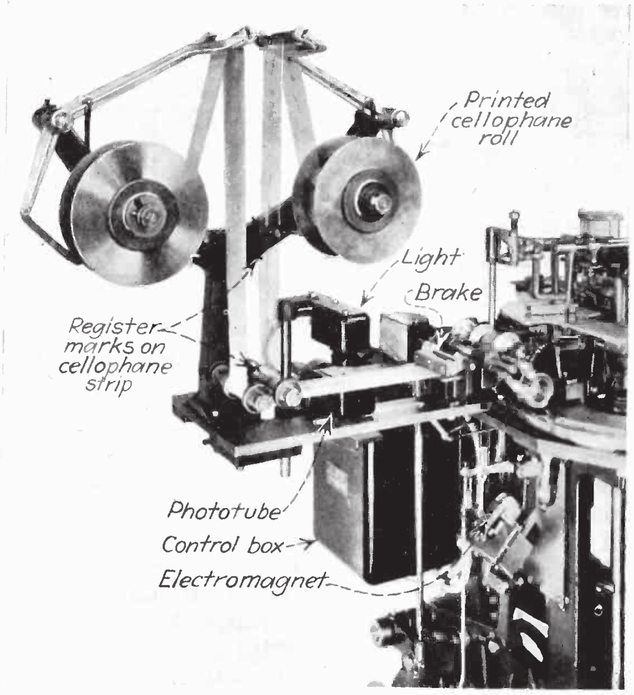


Fig. 2—How clapper-type magnetic brake stops paper at proper point, when brake is released by photocell

Voltage for the phototube is supplied from a 60-cycle a-c source already available at the machine. Although the use of alternating current on the photocell results in periods during each cycle in which no operation can start, variations in paper position arising from this effect are not of importance. The additional expense and maintenance involved in the use of an electronic rectifier and d-c amplifier is unnecessary. A single amplifier tube operating on a-c steps up the photocell output to provide power for the operation of grid controlled rectifier tubes or sensitive magnetic relays. With the grid controlled rectifier or relays tubes there is no time lag in the operation and contact troubles experienced with sensitive relays are eliminated. Being in itself a rectifier, the relay tube supplies half wave rectified direct current to the electromagnet, making it necessary to select an electromagnet for a pulsating current supply.

In this control the relay tube has the additional advantage of operating on less power, and therefore involving a lower amplification ratio. With low amplification ratios the amplifier is more stable in operation. Only one adjustment, a means for varying the sensitivity of the photo cell, is needed. To give the relay tube time to warm up so that its operation will be stable, a five-minute time delay switch is automatically connected in the relay output when the power is switched on.

A study of Litz wire coils for i-f and r-f transformers

THE need for standardization, and if possible simplification in the use of Litz wire for r-f and i-f coils has been apparent for some time. Several types of Litz wire have been available and have been used. Some of this Litz is composed of many strands of fine wire, some of it of larger wire and fewer strands; the possible combinations seem infinite. Therefore, manufacturers of the wire and its users in large quantities have thought it desirable and economical to determine if a few sizes would not fill all the bills—and so eliminate those not really necessary.

At the suggestion of Mr. Virgil Graham of the RMA Standards Section, a study was undertaken by William S. Barden and David Grimes of the RCA Licensee Laboratory. These notes are taken from a voluminous report on their research.

Typical coils were supplied by the F. W. Sickles Company, the Acme Wire Company and the Meissner Manufacturing Company. In addition to coils now made and used in numerous receivers more than 300 special coils were supplied to aid their work, not to determine the best possible coil, but to have available a wide range of information.

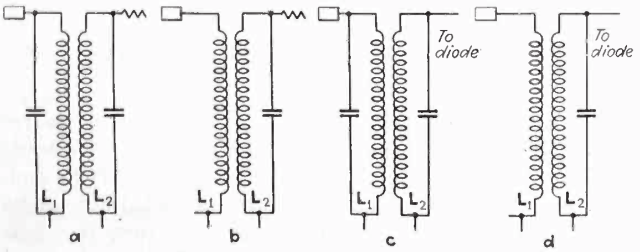


Fig. 1—Typical systems of coils used at intermediate frequencies

The exact influence of coil properties on the performance of an i-f system is a complicated function of the system and not a simple function of an isolated coil. Therefore, the various coil data are translated into terms involving the entire system. In general two coils coupled and each tuned to resonance are assumed to have critical coupling; the plate resistance of the tube across the primary of all coils is assumed to be 600,000 ohms.

The frequencies at which measurements were made are 175, 260, 450, 550, 1,000 and 1,500 kc. An expression involving coil merit is solved for several typical systems; for example, tuned primary and secondary, two stages of tuned primary and secondary, the second of which feeds a diode detector, and so on.

These expressions will be found below. They are useful in comparing two coils to be used in a given system. The expressions involve the resistance and inductance of the coil and a tube of 600,000 ohm resistance. Coils which work into a diode detector are disregarded, because the damping due the diode on the secondary and the previous tube on the primary is so great that any changes in the system performance produced by coil betterment are slight.

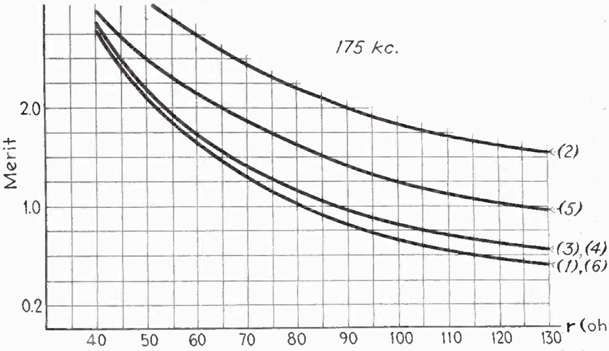


Fig. 2—Curve for determining relative merit of coils

Combinations actually used in practice and analyzed are shown in Fig. 1 and the figure of merit for each system as related to the coils is shown in the table below.

System 1	Two stages *a*	$(\omega L)^4/rB$
" 2	One stage *a*, one stage *d*	$(\omega L)^2/\sqrt{rB}$
" 3	One stage *c*, one stage *a*, one stage *d*	$(\omega L)^3/r\sqrt{B}$
" 4	One stage *b*, one stage *a*	$(\omega L)^3/r\sqrt{B}$
" 5	One stage *a*, one stage *c*	$(\omega L)^3/\sqrt{rB}$
" 6	One stage *b*, one stage *a*	$(\omega L)^4/rB$

where L = coil inductance = $L_1 = L_2$
r = coil resistance = $r_1 = r_2$
$B = rR_p + \omega^2L^2$

These expressions are derived by considering that the inductance is maintained constant and that the resistance is varied. The figure of merit for such a coil has two factors, one for the secondary, which varies inversely as the square root of the resistance, and one for the primary, which is somewhat more complicated. It is actually equal to $\dfrac{\omega L}{\sqrt{R_p r + \omega^2 L^2}}$

Therefore, a single transformer between tubes, both primary and secondary, tuned, has a figure of merit equal to $\dfrac{\omega^2 L^2}{\sqrt{r}\sqrt{R_p r + \omega^2 L^2}}$ and two stages of this transformer between the proper tubes will have a figure of merit equal to the square of the above expression.

Suitable values of inductance are 8 mh. at 175 kc., 2 mh. at 450 kc. and 4 mh. at 260 kc. Other values are found in practice, but in general they do not differ greatly from these figures.

Using the figure of merit given above for Fig. 1a (tuned primary and secondary) and plotting it against resistance Fig. 2 is obtained, in which the ordinates have arbitrary values only. Such a figure is to be used only to compare two coils; thus to get the percentage by which one coil is better than another in any of the six systems, it is only necessary to use ratios of ordinates in Fig. 2.

As an example, consider System 1 (two stages of tuned primary and secondary) using coils of 70 and 90 ohms, the percentage betterment of the lower resistance coil is $\frac{1.2}{.85} - 1 \times 100\%$, or 14.1 per cent.

Therefore, System 1, with 70-ohm, 8-mh. coils, working at 175 kc. is 14.1 per cent better than one using 90-ohm coils.

The numbers on the individual curves in Fig. 2 indicate the system the curves are to be identified with. No significance is to be attached to the fact that one curve is higher than another. Similar curves for use at 260 and 450 kc. are included in Mr. Barden's paper.

Selectivity considerations

So far, only voltage gain has been considered. An analysis of selectivity leads to the fact that systems as well as isolated coils determine the relative merits of various Litz wires from the standpoint of selectivity. System 1, composed of two stages of doubly-tuned coils appear to be a suitable single premise on which to base Litz wire comparisons as regards selectivity because it embodies conventional means of obtaining requisite selectivity.

From a series of resonance curves, for each I.F. the effect of various resistance coils can be determined. Discrimination against 10 kc. interference is taken as the figure of merit. Fig. 3 shows the relative value of coils of different resistances so far as attenuation 10 kc. off resonance is concerned. Similar curves may be made for use at other intermediate frequencies.

A comparison of Fig. 2 with Fig. 3 (and similarly of curves at other intermediate frequencies) will show that if the gain charts were to be disregarded, and selectivity alone chosen as a basis of Litz wire comparison, the best wire thus found would likewise be the best from the standpoint of gain. If gain alone be chosen as a basis of comparison, the best thus found would likewise be the best from the standpoint of selectivity.

The resonance curves for 175 kc. are so sharp as to seriously attenuate side bands, thus affecting fidelity. This is particularly true when the resonance curves are compounded for the system (two of Fig. 1a) on which interpretations are based. At 260 kc., the same reasoning applies, although to a lesser degree. At 450 kc., the adjacent channel selectivity is poor, and side-band attenuation is not a serious factor. It is evident that 450 kc. should be given first consideration, and that the best Litz wire found for that use be regarded as possibly good enough for general use at 175 kc. at 260 kc.—and then studied from that standpoint.

As regards the possible choice of a single Litz wire specification without seriously impairing design possibilities at any of the usual intermediate frequencies, the matter of fidelity appears to deserve considerable weight. It would seem ridiculous to choose a particular Litz wire specification for 175 kc., when that wire is so worthy as to outrule its practical use—and require that losses be intentionally introduced. For these reasons, the best Litz wire for 450 kc. is to be compared with the best Litz wire at 175 kc. and 260 kc.

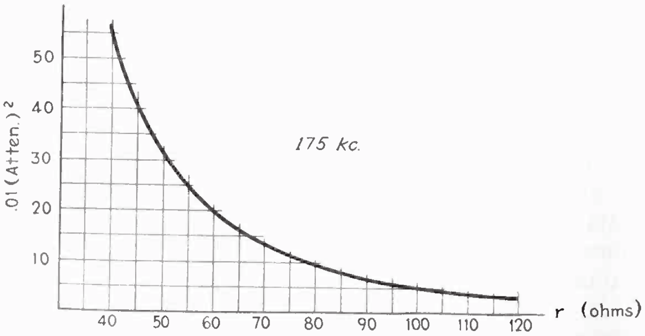
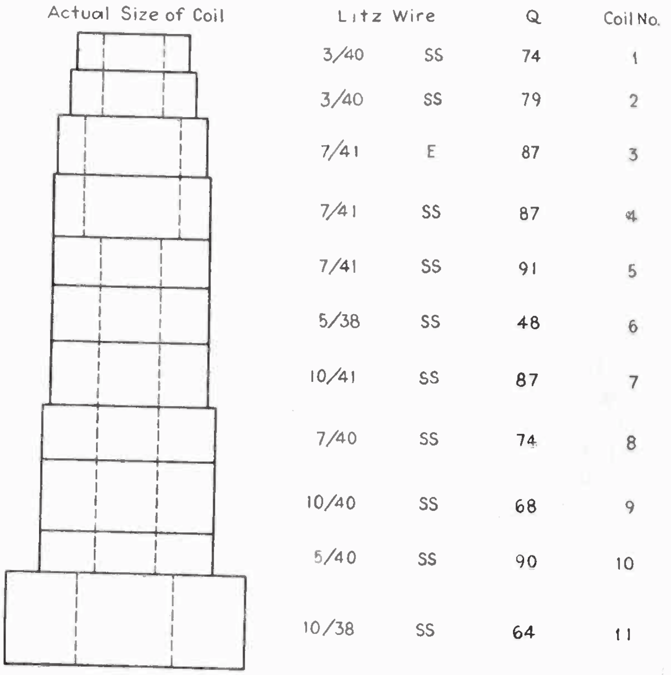


Fig. 3—Resonance curve showing attenuation 10 kc. off resonance

In Fig. 4, eleven coils are shown in actual size. Important data are given as measured and rated at 450 kc. The figure shows actual coil sizes.

Coil 1 is the smallest, and is by far smaller than the largest. No. 1 wound with 3/40 SS Litz wire, with a Q of 74 disproves the notion that very small coils cannot be good and that only three strands of No. 40 wire are not worthy of the name "Litz." Now coil 1 does not indicate that 3/40 is "low-resistance-per-foot wire," but rather that a suitably small amount of that small wire is required for 2 mh. and that the smallness of the wire leads to favorable physical and electrical properties of the coil.



Litz Wire		Q	Coil No.
3/40	SS	74	1
3/40	SS	79	2
7/41	E	87	3
7/41	SS	87	4
7/41	SS	91	5
5/38	SS	48	6
10/41	SS	87	7
7/40	SS	74	8
10/40	SS	68	9
5/40	SS	90	10
10/38	SS	64	11

Fig. 4—Actual sizes of 2-mh. coils used at 450 kc.

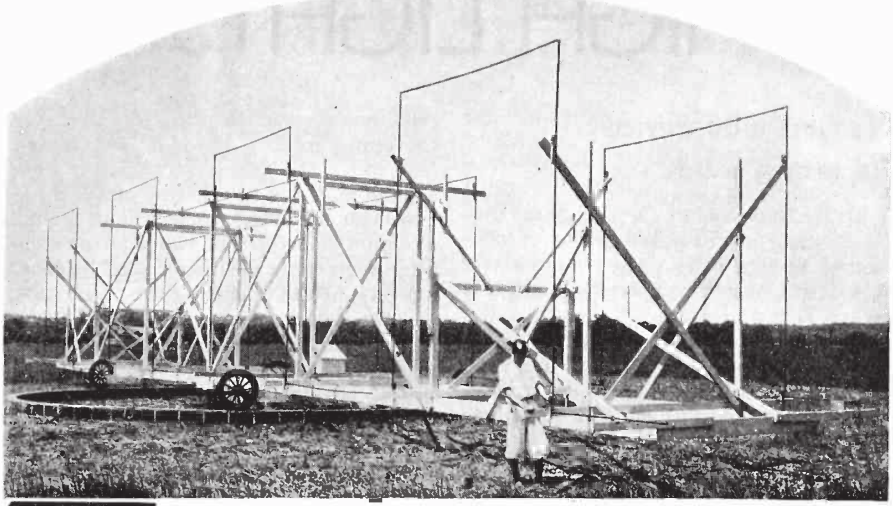
Coil 11, the largest coil wound with 10/38, has the lowest value of Q. This is no evidence that 10/38 is poorer than 3/40, but it is evidence that the isolated merit of 10/38 cannot be realized in a suitably small coil. Litz made of 10/38 is not well suited for typical i-f coil design, because of the physical size of the wire, and the consequent size of the coil. Accordingly, 10/38 is given no further serious attention.

In coil 2, the turns are spaced a little more than in coil 1, resulting in a larger coil for the same inductance. The increase in Q may be due to an improved form factor, or to a decrease in resistance caused by proximity effect of the turns (or both).

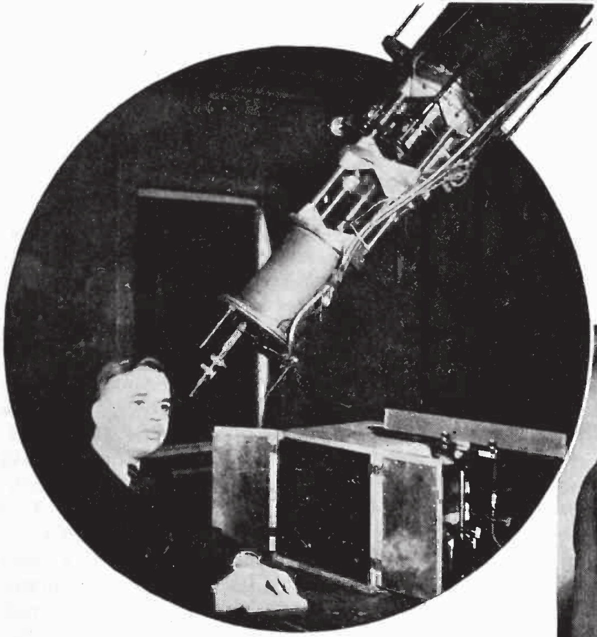
In coils 10, 8 and 9, which have 5/40, 7/40 and 10/40 wire, respectively, and, progressively, room for the increasing number of strands is made by increasing the thickness of the coil.

[Editor's Note—The second and concluding part of this work on Litz wire coils will appear in a near issue of Electronics.]

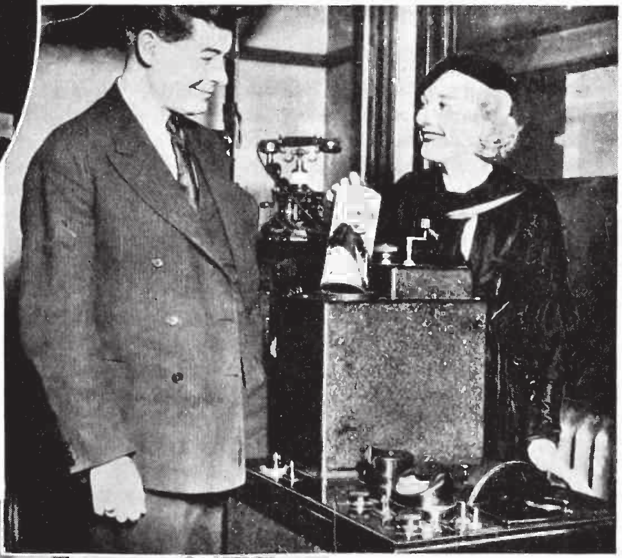
ELECTRONS IN THE NEWS



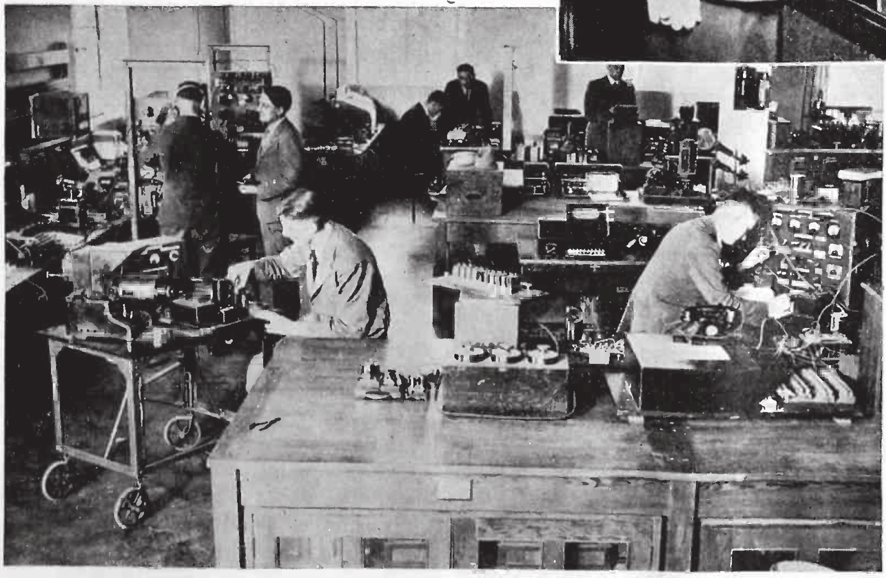
This revolving antenna array was developed by Karl G. Jansky, of the Bell Laboratories, Holmdel, N. J., station, to locate and measure static and interference from passing thunderstorms. With it, he detected his now-famous "radio from the stars"



Stars down to the 14th magnitude can be detected, and stars of the ninth magnitude can be measured by this photo-electric photometer of Dr. A. E. Whitford, University of Wisconsin



The German General Post Office is now equipped to send photographs by facsimile to London, Budapest, Rome, Oslo and Christiana. Here's Margot Grahame, European screen star, dispatching an autographed portrait



The new research laboratories of the British General Post Office at Dollis Hill, London, have just been opened with ceremonies in which the Prime Minister headed the list of notables. It is here that technical advances for the wire and radio circuits of the British service are developed and given practical application

HIGH LIGHTS ON ELECTRONIC

Vacuum-tube device for testing welds

J. R. Batcheller of Oregon State College, employs an exploring device consisting of two coils wound on the two legs of a V-shaped magnetic circuit, this circuit being closed by the weld under test, or for comparison purposes, by the stock metal from which the weld is made. Alternating current from a single tube with inductive coupling between plate and grid is sent over a transformer and a low-pass filter to a Wheatstone impedance bridge, one arm of which contains the two exploring coils placed in series with a variable condenser. The condition of balance is indicated by a three-tube amplifier and detector as the coils are shifted from the stock to the weld. This portable instrument gives correct results in 90 per cent of the cases.

Phototubes operate soaking-pit covers

Before being rolled, steel ingots are required to soak several hours at 2,500° F. in covered eight-foot square pits, ten feet deep. Overhead cranes continually open and close these pits; putting in cold 40,000-pound ingots or taking out hot ones. In older mills the craneman must wait for a man on the floor to uncover the pit; more modern mills place the pit cover control in the cranemen's hands by auxiliary control rails along the crane track; but the newest system requires that the crane operator merely shine a light beam on a photo tube, thus getting rid of all direct mechanical and electrical connections.

The fourteen soaking pits equipped extend in a long double lane. High on the wall above is a dual row of photocells, one for each soaking pit cover. On the crane are two ten-foot lamp boxes, one above the other, for making light contact with the double row of Westinghouse photo tubes. Such a long trough of lights relieves the craneman of stopping in an exact position above the soaking pits, before operating the photo tube.

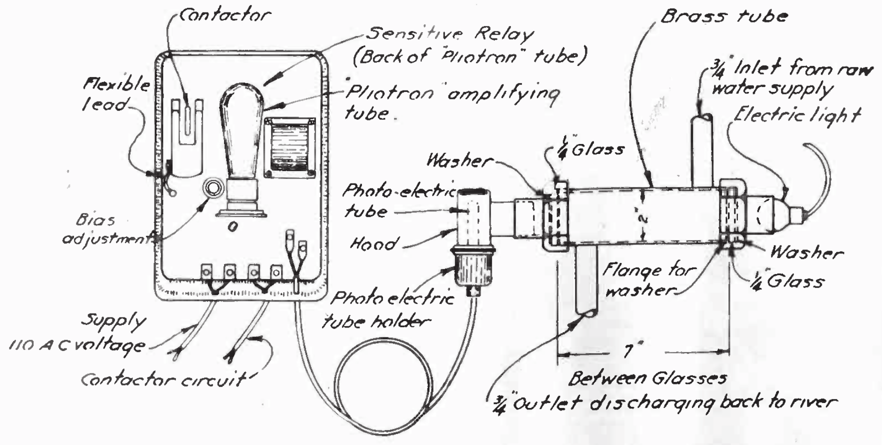
In operation, the craneman stops over the pit and turns on the lamp box for a moment, the soaking pit cover obediently slides back, he puts in an ingot, momentarily switches on the lamp box, and the ponderous lid closes itself without further attention.

Photocell watches turbidity of Denver water supply

Most of the Denver (Colo.) water supply is diverted from the South Platte River at Intake in the South Platte Canon, 23 miles from the city. Generally the water of this mountain stream has a low turbidity but during certain seasons, particularly in the spring due to heavy rains and melting snow, trouble is frequently experienced from a sudden rise in turbidity. Sometimes it is also necessary to eliminate the flow of water from the intake to the filter plants due to heavy turbidity which may occur.

"The variation in turbidity creates additional problems in the handling of the water," explains George J. Turre, chief chemist for the Denver Board of Water Commissioners. "It is necessary for the operator at the Intake to keep a vigilant watch as to the turbidity of the water. This watch must be kept during the day and night so as to give warning of any necessary change in the handling or treatment of the water."

From laboratory experiments, using photoelectric relay units, with the idea of applying this device as a means of protecting the rise or fall of turbidity in the river, it was decided to try out this equipment for the service outlined. The device was set so it would operate on a turbidity of 100 or more p.p.m., in order that a warning signal would be given to the operator when the turbidity reached that point. The photoelectric tube is more accurate in determination than the human eye and is of material assistance to the operator in giving immediate warning of a rise or fall in turbidity. This device also has possibilities for noting air-bound conditions in filter plants and other features of water works operation.



Arrangement of photocell and lamp for detecting turbidity in Denver (Col.) water supply

Photocell smoke and fire-alarm

The "Atlantique" catastrophe has naturally increased interest in France in the problem of indicating the beginnings of fires on board ship, not only in the holds, but also in the passenger quarters.

A new device, due to Chilowski, deserves attention for the very simple form in which one and the same inexpensive device detects either smoke without flame, or flame without smoke (or, of course, the two combined). This detector, small and simple enough to be fitted in every cabin, consists of a small lamp throwing its beam onto a mirror, which reflects it back to a photo-cell. The action in the case of smoke is obvious, for the detection of flame the mirror is mounted on an axis, controlled by two parallel stretched wires, one of which is bare and the other coated: in the case of a sudden rise of temperature the unequal expansion rotates the axis, and the mirror moves, thus cutting off the beam.

Each detector is connected to a relay at the central office. The construction of these relays is also novel, since they must be unaffected by considerable movement (rolling, etc.) and operate even when out of plumb. Each consists essentially of a vertical magnetic rod immersed in a liquid of the same specific gravity, between two coils. These coils are both supplied with current from a local source, in one case through a rheostat, in the other through the cabin detector, and normally they are made to balance. The action of the detector destroys this balance and the rod rises, bringing into view a disc-indicator with the number of the detector. Simultaneously this disc cuts off the beam from a lamp at the control station of a photo-cell there, and so operates a visual or audible alarm.

DEVICES IN INDUSTRY + +

Carrier current for power station load control

THE FIRST APPLICATION OF carrier-current equipment for load-control purposes has been made in New Hampshire, in connection with two fully automatic hydroelectric stations operated by the Twin State Gas and Electric Company, known locally as the New Durham and Merrymeeting stations.

The output of the Merrymeeting station is supplied to the system over a 4,000-volt line through the New Durham station, where the connection to the main system is made. An operator living near the New Durham station has supervision over both, with suitable instruments at New Durham to indicate the load that is being carried by the Merrymeeting station. Starting and stopping of the latter is accomplished by closing or opening the oil circuit breaker in the New Durham-Merrymeeting line at New Durham.

A separate cable circuit was previously employed in the load control of the Merrymeeting generator, but the cable circuit became so unreliable that complete replacement of the control channel recently became necessary. Two years of highly satisfactory operation of carrier-current telephone equipments on the lines of the company led to the decision to use similar equipment for control of the load at Merrymeeting.

A General Electric single-tube carrier-current signal transmitter (Type GCS) was installed in the New Durham station, and a double receiver (Type SCS) with coupling capacitors at Merrymeeting. A coupling to one phase of the line with ground return is used.

The two elements of the double receiver operate on opposite half waves, and consequently their independent actions depend on the relative instantaneous polarity of the supply voltage to the transmitter and receiver. Permanent connection to the supply voltage (110 volts, 60 cycles) is made at the receiver, and a standard double-pole double-throw governor control switch is used to reverse the supply connection to the transmitter. Each element of the double receiver controls the operation of the motor-operated gate-limit control, one element to open the gate and the other to close it.

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The steel bar and the "magnetic hand"

IN A NOVEL EXHIBIT OF THE Republic Steel Corporation, a bar of stainless steel weighing one hundred pounds is nearly balanced on a fulcrum, one end of the bar resting on a table.

If a visitor approaches the heavy bar and passes his hand over it, amplification of the static charge, by means of thyratron circuits, is sufficient to lift the unbalanced end of the bar, and to cause the bar to float upwards following the hand. Thus the visitor's hand appears to be "magnetic" and to attract the steel bar.

The bar can be similarly lifted by holding the hand over a plate at some distance from the bar.

This exhibit was shown at the Steel Treaters' convention, and will be displayed at other shows. It was arranged by R. D. McDill, of the Electronic Inspection Laboratories, 1624 Hayden Ave., Cleveland, Ohio.

To warn truck drivers to turn out for motorists

BY DR. E. E. FREE

A NEW DEVICE TO NOTIFY truck drivers on the roads whenever a motorist wants to pass them from behind has been approved by French police authorities and is expected to be made required equipment on all French automobile trucks after the first of next year. It consists of a cheap and rugged photo-electric cell fastened to the back of each truck and connected with a vacuum-tube amplifier. Whenever a motorist approaches from behind and wishes the truck to turn out, all that he needs to do is to turn on his headlights. Light rays from these headlights enter the photo-electric cell on the back of the truck and create an electric signal. This is magnified by the amplifier and rings a warning bell in the truck driver's cab. To prevent willful refusal of truck drivers to yield the road, an attachment can be provided which records the exact times of any signal given by the warning apparatus.

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Filamentless tubes for elevator control

THE FILAMENTLESS TUBES developed by Dr. August Hund in the laboratories of Wired Radio, Inc., Ampere, N. J., have been applied in some test circuits for elevator control. The tubes thus used are rectifiers, and are now on preliminary life-tests to determine period of operation. So far no definite aging is reported discovered. Following the life tests, the tubes will be operated in actual elevator control circuits.

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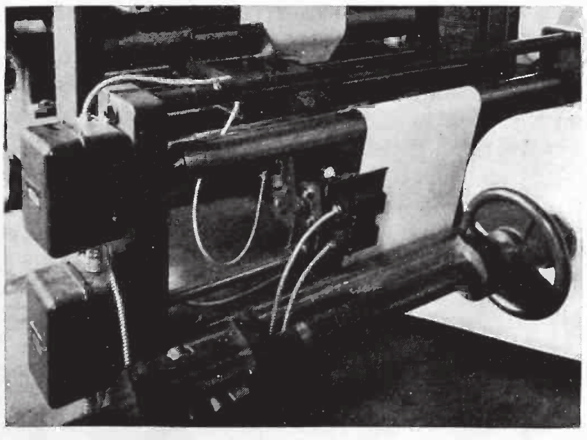
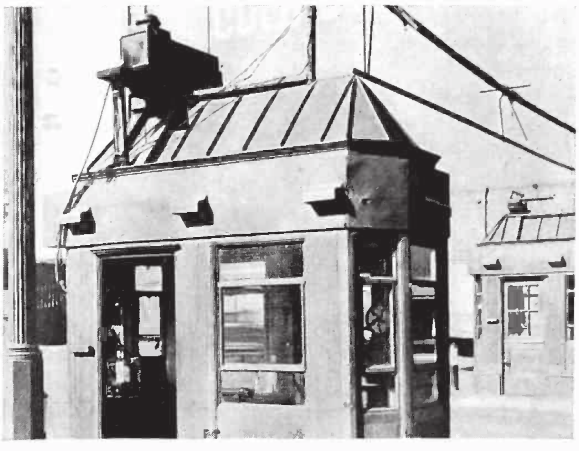
SIDE-REGISTER CONTROL OF PRINTING



In this Smith & Winchester tuber, for paper bags, at the Arkell plant in Canajoharie, N. Y., photocells position the paper on the rolls

HIGH-TRUCK ALARM FOR TUNNEL



The projector on the nearby toll-house throws a beam into the hooded photronic cell at right. Any intercepting truck starts an alarm ringing

Radio acoustic ranging

By DAVIS BELCHER

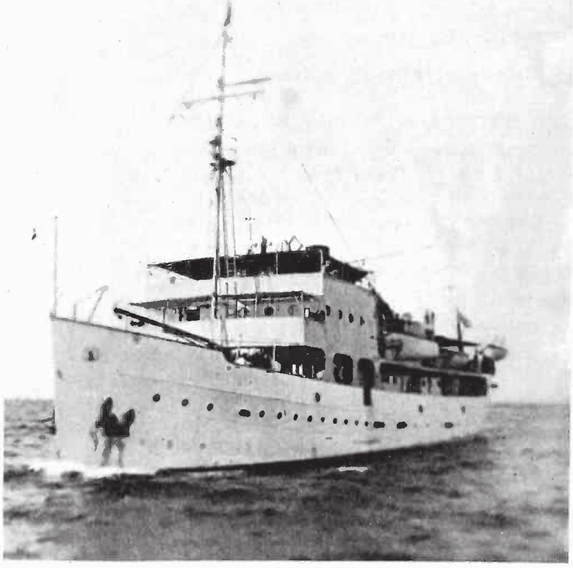
U. S. Coast and Geodetic Survey
Port Arthur, Texas

DURING the war, the development of submarine detectors stimulated research into the determination of the velocity of sound in sea water. This work was carried on by many able investigators in this country and abroad, and formulas were derived for the calculation of the velocity of sound in sea water for any probable condition of temperature, salinity, or depth.

Following the war, the British Admiralty carried out a series of experiments to determine the feasibility of using equipment of this type for the location of merchant vessels. In the procedure employed, the vessel threw a bomb overboard and the sound-wave resulting from its explosion was received at submarine microphones, called hydrophones, anchored near the coast. Simultaneously with the explosion of the bomb the radio operator on board the vessel sent a dash which was automatically recorded at the microphone stations. The time elapsing between the arrival of the radio signal and the arrival of the bomb wave, multiplied by the velocity of sound in sea water, gave the distance to the vessel. Two such distances served to establish a "fix" on the vessel. Of course, any delay on the part of the radio operator in transmitting the dash following the bomb explosion will result in an error in the position. However, if three hydrophones are employed, the time intervals between the arrival of the bomb wave at the three microphones will locate the sound source without any firing dash being transmitted from the vessel.

This method of locating vessels proved to be extremely accurate, surpassing the radio compass, and was of particular value in regions where the radio-compass was subject to considerable error.

In the United States this phase of radio-acoustic ranging is little used, due in part to the high efficiency of our radio-compass system which is maintained and operated by the Navy. However, a development of it has found wide application in the work of the Coast and Geodetic Survey, an arm of the Department of Commerce. The hydrographic work carried on by the Coast and Geodetic Survey suffered greatly from loss of time due to poor visibility, and, in an effort to overcome this, attention was directed to survey methods other than visual sighting. A process of elimination resulted in the selection of radio-acoustic ranging as a method possessing sufficient accuracy to be adaptable to hydrographic work. Certain modifications from the English procedure were desirable, however.


Yacht "Hudie," employed as hydrophone station

The construction of accurate charts required that the position of the survey vessel be determined frequently and rapidly to permit a desired course to be maintained, also it was desirable that the calculations necessary to fix the vessel's position be carried out on board the vessel and not at the hydrophone station.

The only feasible method for accomplishing this is to employ a radio transmitter so arranged that it is keyed automatically by the arrival of the bomb signal at the hydrophone. Experiments and investigations carried out by the Coast and Geodetic Survey have developed a technic suitable for its needs.

The following arrangement has been worked out. Two hydrophones, whose positions are accurately known, are connected either to temporary shore radio stations or to radio-equipped launches. The survey vessel sets a course and starts sounding. Every few minutes a small bomb is thrown overboard. The explosion of this bomb is recorded on board the survey vessel and at the same time a warning radio signal is sent to the hydrophone stations to inform the operators that the bomb has exploded. The bomb wave arriving at the hydrophones acts to key the transmitters and returns a dash to the survey vessel from each station. The time interval between the bomb explosion and the return radio signal from a station is multiplied by the velocity of sound in sea water to obtain the distance. As the location of the two hydrophones is known the two distances serve to fix the survey vessel's position.

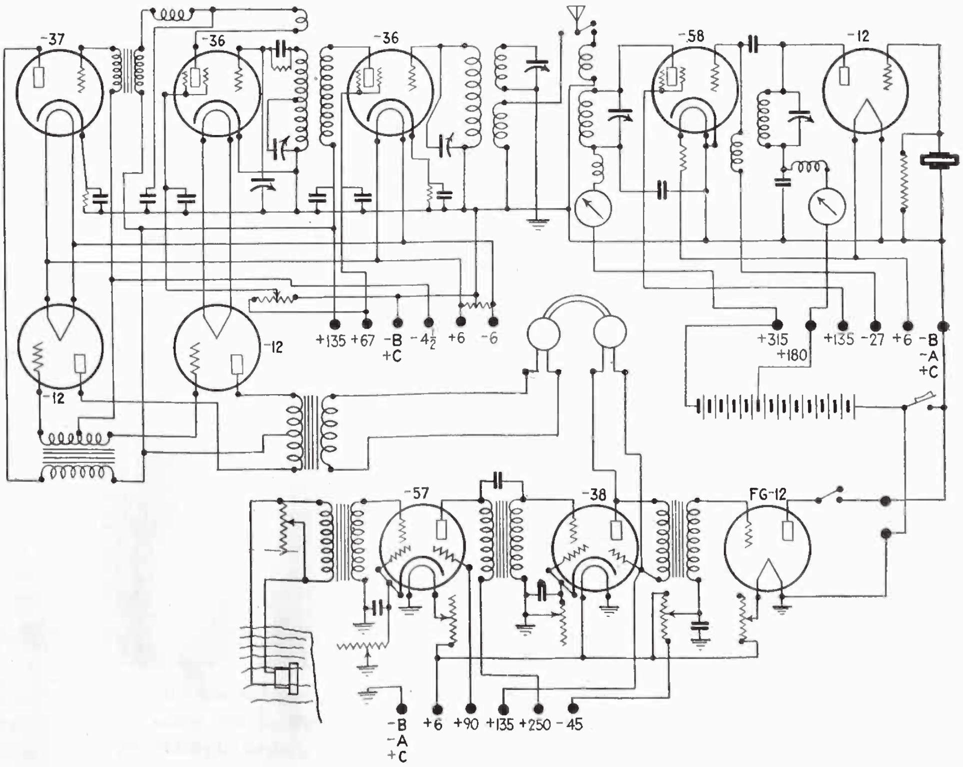
The hydrophone unit itself consists of a brass casing with a phosphor bronze diaphragm within which is mounted a Baldwin loudspeaker unit with a mica diaphragm. The construction is such that the mica diaphragm is fastened at the end of an air column that starts behind the phosphor bronze diaphragm. By this means the varying pressure of the incident sound wave is transmitted to the mica diaphragm with little loss. The hydrophone unit while in service contains compressed air at a pressure somewhat in excess of the hydrostatic pressure at its working depth. This serves to cushion the diaphragm and to oppose water leakage. The cable from the hydrophone terminates in an amplifier at the radio station.

This amplifier serves a dual purpose. It serves to amplify the bomb signal and also to key the radio transmitter. To accomplish the latter, a thyratron is connected to the second stage of the amplifier and to the transmitter, as shown in the diagram of equipment on board the yacht *Hudie*. Sufficient signal voltage from the amplifier overcomes the grid bias and permits plate current to flow through the thyratron and the transmitter. Of course submarine noises other than the bomb waves can and do occur and are often of sufficient intensity to release the thyratron. To overcome this, a potentiometer is employed for varying the grid bias on the thyratron; increasing the negative bias necessitates greater signal voltage from the amplifier to release the thyratron. The gain control across the hydrophone can be used to give this greater signal voltage, but if trouble is encountered from water noise this is of no help, because all sounds incident on the microphone will be amplified equally. The usual solution is to adjust the amplifier and thyratron to the most sensitive position that conditions will permit and then increase the size of the bomb until satisfactory returns are obtained. The danger is always present, however, that unexpected noises may occur and key the transmitter a few seconds previous to the arrival of the bomb signal and mar the returns. To aid in preventing this, a switch is connected in the plate circuit of the thyratron. This is kept open until a second or two before the bomb wave is due and then closed. By this means the interval during which an interfering noise can key the transmitter is greatly reduced and in practice little difficulty is encountered. The approximate time for the arrival of the bomb wave is always known. The use of a stop watch, which is started when the warning signal indicating that the bomb has exploded is heard, permits the operator to close the switch at the proper time.

The radio transmitters used at the temporary shore stations or aboard the radio-equipped launches are of the oscillator-amplifier type, with crystal control. They are of very low power, but are sufficient to return a good signal over a distance of about 50 miles, which is sufficient for the work. Plate power is obtained from heavy duty B batteries. The crystals at all hydrophone stations are as close to the same frequency as possible to permit their signals being received at a single receiver setting on board the survey ship. The possibility of both return signals arriving together can be eliminated by care in locating the launches to assure a sufficient time interval between the reception of the bomb wave at the two hydrophone stations.

When the bomb explodes astern of the survey vessel, a hydrophone mounted in one of her water tanks picks up the wave and records it on the moving tape. The radio signals returning from the hydrophone stations are received at the survey ship, amplified, and similarly recorded. Another needle simultaneously traces a time record on the tape and from this the time intervals can be measured. The time required for the transmission of the radio signals is negligible, as compared with the time required for the propagation of the sound wave. So neglecting it, we obtain from the tape the time required for the bomb wave to reach each hydrophone station. The product of time and velocity gives distance, and these two distances serve to fix the survey vessel's position.

Although fair work has been done with the equipment shown, yet it depends too much upon maintenance and understanding on the part of the radio operators to be truly satisfactory. It is hoped that new equipment embodying the improvements outlined above will be still more successful. The application of the electron tube to hydrographic work is barely begun. The passage of another year or two will find the hydrophone and its associated radio equipment located on large buoys, where it will be able to operate continuously for weeks.



Circuits of equipment used on yacht "Hudie"

Some difficulty has resulted from the use of the metal cabinets as common returns, preventing common grounding. A resistance between B minus and the thyratron filament, and another amplifier stage, are also suggested as improvements for future equipment

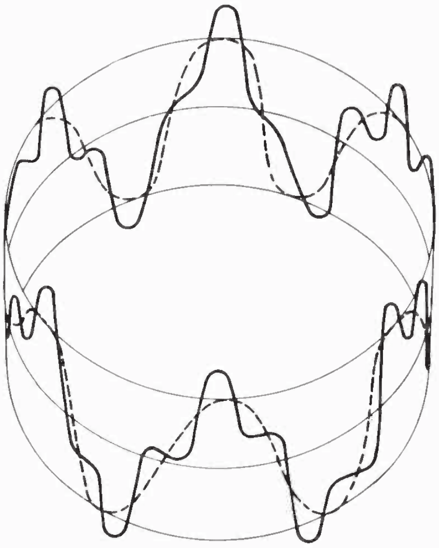
+ + ELECTRONIC NOTES

Frequency comparison with the cathode-ray oscillograph

By C. B. Fisher*

The low voltage cathode-ray oscillograph has found perhaps its chief application in frequency comparisons by means of Lissajous figures and has been used more particularly for calibration of multi-frequency vacuum-tube oscillators at frequencies of 20 to 100,000 cycles.

Briefly, the method consists of applying a voltage from an oscillator of accurately known and constant frequency, which we shall call the "standard oscillator," to one pair of deflecting plates of the oscillograph, and the output voltage from the oscillator under test to the other pair of deflecting plates. The frequencies are adjusted until certain known patterns, called Lissajous figures after their discoverer, are formed on the screen of the oscillograph. When this ratio is that of two small integers, the smaller always being the numerator, the figures are simple, but as the integer expressing the numerator becomes greater than four, or the denominator greater than about 12, when the ratio is reduced to its lowest terms, the figures become of a complexity which renders their certain identification slow and difficult.



To secure simpler figures a variable-frequency reference oscillator is commonly employed. It is adjusted by comparison with the standard oscillator to a frequency two, three or four times the interval between successive points of calibration of the oscillator under calibration and then by comparing the reference with the test oscillator, the points at which the test oscillator is to be calibrated are picked up. For example suppose we have an oscillator which we wish to calibrate at points every 25 cycles from 1,000 cycles to 1,500 cycles, and suppose that the standard oscillator to be used has a frequency of 1,000 cycles. By using the standard we first pick up the Lissajous figure which represents a frequency ratio of 1:1 corresponding to a frequency of 1,000 cycles for the test oscillator, and then we pick up the Lissajous figure representing a 2:3 frequency ratio, making sure that it corresponds to a frequency of 1,500 cycles, and not 666.7 cycles, for the test oscillator. The reference oscillator is now adjusted, by comparison with the standard oscillator, to 100 cycles. The oscillator under test is now set to the previously determined setting for 1,000 cycles, and compared with the reference oscillator. A single-line figure should appear. The test-oscillator frequency is then increased in small steps, and four-, two-, four-, and single-line figures are successively picked up, corresponding to frequencies of 1,025, 1,050, 1,075 and 1,100 cycles respectively for the test oscillator. This process is continued, the figures repeating themselves in the above order, until 1,500 cycles is reached. At this point the test-oscillator setting should correspond with that previously determined for this frequency by comparison with the standard oscillator. Such a correspondence gives a check on two things. First, it ensures that no figures have escaped notice during the calibration, i.e. the point found is not 1,600 cycles for example, thus relieving the operator from the necessity of counting the number of waves in each figure obtained, it being sufficient to count the number of continuous lines in the figure. Second, it gives an indication of any drift that may have occurred in the reference-oscillator frequency during the time which elapsed since the adjustment of the reference-oscillator frequency.

Let us consider this point further, as in practice such a drift is often found to occur, and may be quite important, necessitating frequent checks. In the first place, the reference oscillator will not in general have inherently as stable a frequency as that of the standard oscillator. The reference-oscillator frequency ordinarily will be changed several times in an hour, while the stand-

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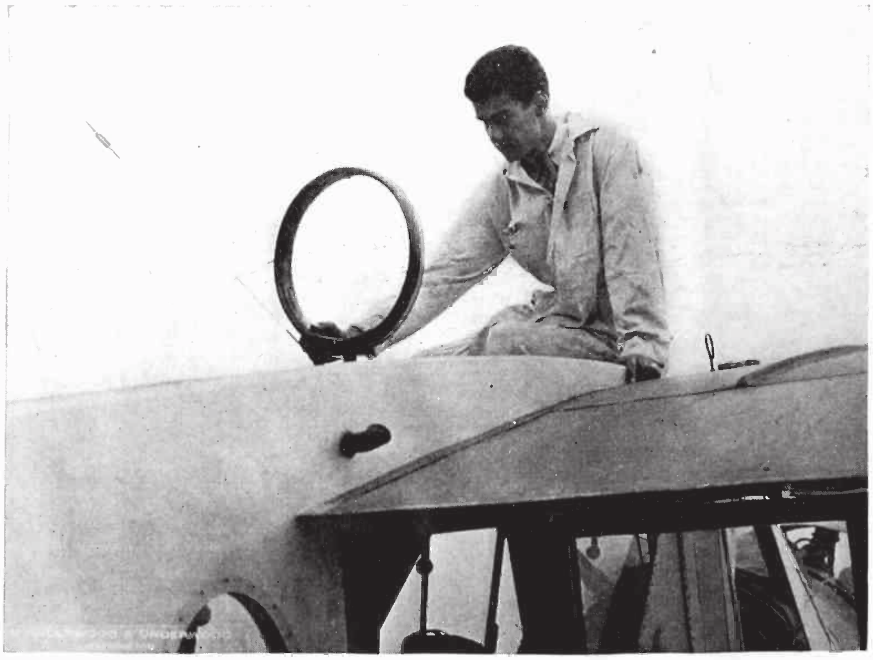
Every radio station a guide for airmen

By means of a new device recently developed by the radio division of the Bureau of Standards at Washington, aviators going "cross country" over territory not equipped with the regulation radio beacons may set their course using signals from a conventional broadcasting station in the vicinity. A small loop antenna mounted on the top of the plane may be rotated until the desired station is located and then a simple indicating device on the dash permits the pilot to hold his course even in the thickest weather.



Justus Steele, an employee of the College Park airport, near the Capital City, is seen examining a small round loop mounted on the top of the plane, which may be rotated to bring in the signals from the desired direction

FROM THE LABORATORY ++

ard oscillator may run continuously. Thus changes in frequency due to unequal heating of the circuit elements may become important. Finally, the reference-oscillator frequency is ordinarily from a twentieth to a fifth of the standard-oscillator frequency. The correspondingly larger tuning elements are much more liable to changes in electrical values than are the elements of the standard oscillator.

Accordingly, to permit rapid, accurate calibrations to be made, it is desirable to maintain a continuous check on the frequency of the reference oscillator. A neat and practicable method has been used by the author with considerable success.

The outputs from the standard oscillator and the test oscillator are applied simultaneously to the vertical deflecting plates of the oscillograph. The reference-oscillator output is applied to the horizontal deflecting plates. When exact ratios are obtained, figures of the type shown are seen. This figure is seen to be similar to the usual Lissajous figure, but with a sine-wave ripple running around the periphery. Similar figures may be formed of two, three or four lines.

Any departure from synchronism of the reference frequency and the measured frequencies is shown by a motion of the whole figure. Any departure from synchronism of the reference frequency and the standard frequency is shown by a movement of the small sine-wave ripple around the edge of the larger figure. Such a figure then gives a check on the reference-oscillator frequency. At the same time the figures are not unduly complicated and can be picked up and identified after a little practice as readily as can the more usual figures. The calibration is increased in accuracy, and the time may actually be lessened, as the preliminary calibration with the standard oscillator to give points to check in on later may be dispensed with.

**Engineering Department, Northern Electric Company, Limited, Montreal.*

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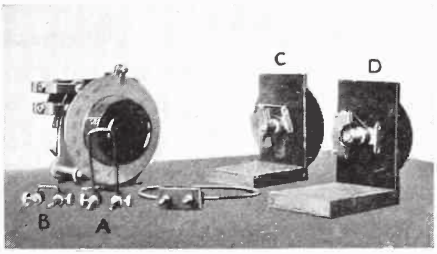
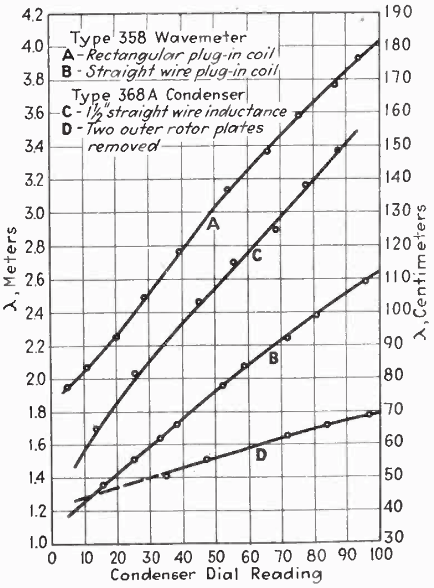
Simple ultra short-wave wavemeters

By W. H. Moore*

It has been the universal practice in measuring wavelengths of the order of one or two meters and less, to make use of Lecher wire systems and wavemeters. If sufficient care is taken, the result may be relied upon to within one-tenth of 1 per cent.



The Lecher wire wavemeter is very satisfactory for making precision measurements of specific wavelengths. It is often desirable, however, to make a number of wavelength measurements quickly where accuracy is of secondary importance, the prime requisite being convenience and rapidity of measurement. For such an application the ordinary absorption type of wavemeter, consisting of an inductance and variable condenser, would be very convenient.



Several wavemeters of this type were constructed by the author for use in connection with investigation on ultra short-wave oscillators. Calibration was done by means of Lecher wires. Resonance was indicated by a deflection of the plate current meter when either Lecher wires or wavemeter was coupled sufficiently closely to the oscillator and tuned to the wavelength of the oscillations.

The single turn coil in the center of the photograph is the regular 4-6 metre inductance used in conjunction with the condenser shown at the left to form the General Radio Co. Type 358 short-wave wavemeter. Two other inductances, A and B in the photograph, were constructed to be used with this same condenser. The range covered by the wavemeter with the rectangular coil A, is from 2 to 4 meters, and with the straight wire coil B, from 1.2 to 2.6 meters, or 120 to 260 centimeters.

Wavemeter C consists of a G. R. Co. Type 368a microcondenser of 15 $\mu\mu$f. max. capacity, in parallel with an inductance composed of a straight piece of wire 1½ inches long connected directly between rotor and stator. The wavelength range covered is from 60 to 150 cm.

The lowest range wavemeter is that shown as D. It consisted of a G. R. Co. Type 368a condenser with the outer two of the three rotor plates removed. The soldering lug on the stator was turned towards the rotor shaft and a globule of solder placed between the end of the lug and the metal bushing carrying the rotor. This globule of solder comprised the inductance of the wavemeter. The wavelength range covered is from 45 to 65 cm., approximately. The lower portion of the calibration curve is shown dotted since it was obtained by extrapolation from the upper portion, wavelengths below 50 cm. not having been obtained experimentally at the time to calibrate the wavemeter over this part of its range.

This series of wavemeters permitted a positive check to be maintained at all times on the wavelengths produced. The fundamental wavelength of oscillation of any particular circuit could always be ascertained definitely, with no possibility of mistaking a harmonic for the fundamental. It was a common error in early work of the author and of others to mistake, for example, a 75 cm. wave indicated on Lecher wires, for the fundamental, whereas this was actually the second or higher harmonic of a true fundamental of 150, 225, or even 300 cms. It was mainly a matter of taking the requisite amount of care to determine which was the true fundamental, of course, but it was an extremely simple matter to be in error by a factor of two or three. By utilizing a series of wavemeters covering from the shortest waves produced up to four or five meters, it was possible to determine very rapidly whether a 75 cm. wave whose presence was indicated, was a harmonic, or the fundamental.

The accuracy of these wavemeters is no greater than the accuracy of the Lecher wires from which they are calibrated, but their usefulness lies in the fact that they indicate but one wavelength at a time, will not indicate harmonics since their intensity is too weak, and in any case can immediately be tuned to double or three times the wavelength to determine whether a higher wave is present or not.

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*The Canadian Marconi Co., Ltd.

electronics

McGraw-Hill Publishing Company, Inc.
330 West 42d Street
New York City

O. H. CALDWELL, *Editor*

Volume VI —NOVEMBER, 1933— Number 11

The listener's end of the radio trail

WITH all the magnificent new studios, costly transmitting plants, and expensive programs of modern broadcasting, it seems pitiful that the listener's "end of the radio trail" in most cases is a flimsy wire picking up noise and interference and feeding into a tinny midget set which reproduces a mere travesty of the studio quality.

Poor sets and careless ignorant installing have made terrific inroads into the good-will of the broadcasters these past two years. It is time for an aggressive effort to be made toward quality of receivers sold, and correct installation.

This is the next big job to be done, if broadcasting is to endure as a great artistic medium.

Yankee inventiveness

AN engineer with radio-circuit experience can find many opportunities to apply photocells and other electronic devices in industrial plants in his neighborhood. But radio or electrical-circuit knowledge alone is not sufficient; the practical electronic engineer will need a good deal of mechanical common-sense and Yankee inventiveness as well.

In fact, as one man of wide experience observes, a mechanically-minded engineer with ordinary inventive ability, is more likely to be successful in the industrial field if he knows the fundamental electronic circuits, than a radio man who knows all about radio but has little sense of mechanical application.

More radio on the farms

MORE people live on American farms today than ever before in the nation's history. Not only has the drift of farm boys and girls to the city been stopped, after thirty years of continuous growth of the city population at the expense of the countryside, but for three years past the movement of the rural migration has been just the opposite way—it now is from city to country. In fact, in these past three years the replacement of farm population has more than equalled in numbers the total population withdrawn from rural districts in the preceding third of a century, so that now more people are living in farm homes than ever had farm homes before.

Most of these 6,000,000 farm houses are without electricity for lighting. Their radios must be battery operated. It is time the radio industry gave more attention to sets especially designed for this vast farm market.

Armstrong's victory, and the courts

THE latest development in the Armstrong-DeForest regenerative circuit litigation establishes as a prima facie case that there is something seriously wrong with our judicial procedure in patent cases.

Entirely aside from the question of whether the present decision is the correct one, it is clear that a system which in a series of proceedings from 1917 to 1924 finds Armstrong to be the inventor, which in another series of proceedings lasting from 1924 to 1933 finds DeForest to be the inventor, and which then determines in 1933 that it was right the first time in holding Armstrong to be first, has many explanations to make to industry.

Uncertainty is a burden which the business executive must forever carry. But what can be more disastrous to his plans than to have litigation in which he is clearly proceeding in his rights appear to terminate favorably, to go forward on the basis of these decisions, and to then, years later, encounter a reversal which places his opponent in control of the situation.

The first electric light

THE neon sign, the filamentless radio tube, and vapor lamps can all trace their origin back to that discovery made by some unknown mariner in the 1600's, that flashes of ghostly light appeared in his barometer tube above the mercury, whenever the barometer was shaken violently.

Above the mercury was a vacuum: shaking the mercury produced frictional electricity. And thus somewhere on the high seas, on some black, tempestuous night, three hundred years ago, the first electric light was born.

From this same faint beginning sprang also a host of other uses, including Geissler tubes, Crookes' tubes, X-rays, neon lamps used for television, stroboscopic tubes, gaseous illuminants.

The next time some skeptical critic, witnessing some interesting new phenomenon, asks "Well, what is it good for?" let him be cited this train of miracles in the track of an apparently useless discovery.

British broadcasting

AMERICAN broadcasting is not the only program service which comes in for sharp criticism. Even the British system, so often held up as a model for American broadcasting, is found fault with by those who have to listen to it.

Although many of the English programs are of high quality, the importance of organization and the value of time on the air are not appreciated. Announcers remain silent for long periods between programs and between the items on programs, leaving the listener to wonder if sudden death has fallen on the performers, if the broadcasting station has been demolished by an act of God, or if his own receiving set has become suddenly inoperative. Little respect is shown for punctuality in beginning or ending a performance, and there is no evidence that the time factor has been controlled by adequate rehearsing.

A charge of 10 shillings per annum is made to all owners of receiving sets, which is perhaps less than the service is worth from an entertainment value. Although no advertising is permitted over the government stations, British firms are beginning to advertise in Continental radio programs, to which the Englishman turns when the domestic entertainment is mediocre on Sunday evenings.

Cab-to-caboose carrier communication

IT is a pretty sound principle of procedure that radio should not be used if wires or other conductors are available to do the work.

We have never found much enthusiasm for the application of radio between the engine-cab and caboose of a long freight train. It would seem that some other guiding or conducting medium would be suited for this purpose, without gumming up a short-wave channel.

A new development of guided carrier-current, worked out in the Schenectady laboratories, seems to supply the answer. Using inductor coils suspended over the rails, and the rails and adjoining wires as the transmission medium, the conductor in the caboose can talk to the engineer in the locomotive cab, with loudspeaker volume that rises well above all train noises. A three-tube transmitter and five-tube receiver are used, operating on 65 kilocycles. Each station consumes 160 watts, with 5 watts at the inductor coils.

The train crew can also talk to other trains, and to stations and dispatching towers within a track distance of five miles.

TOASTING BUNS WITH A 5-M. WAVE

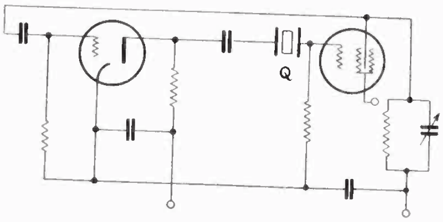
At the Chicago World's Fair, this 20-kw. standing-wave oscillator delivering a 5-meter wave, has been arranged by Westinghouse engineers to toast bun sandwiches by means of the currents induced in the moist bread. This process is similar to that of baking crustless bread "from the inside out" by high-frequency oscillations

REVIEW OF ELECTRONIC LITERATURE

HERE AND ABROAD

Improved quartz-controlled oscillators

[K. Heegner — R. Bechmann, Telefunken Laboratory] According to the usual theory of Pierce's circuit tubes having high mutual conductance and amplification are to be preferred. The higher, however, the grid-plate conductance, the more pronounced is the influence of the changes in grid-cathode capacity caused by the variation of the negative space charge, and the frequency becomes dependent upon the plate potential and the heating current.



The second article describes a quartz oscillator (first used by the broadcast station Langenberg) the frequency of which is not affected by the capacity of the exciting electrodes and the leads (German patent 571,235). The quartz plates are supported in their plane of symmetry along a groove cut at mid-height. The coil serving as thermometer and the heating coil for maintaining the temperature are both mounted inside the evacuated quartz container. The quartz can be calibrated to within 1x10^{-5} (the accuracy of the present frequency meters) and kept constant to within one-millionth.—*El. Nachr. Techn. 10: 357-371. 1933.*

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Electronic tubes in power transmission

[R. Wideroe and Marcel Courtin.] Gas-filled tubes can be connected so as to pass current and furnish power to a relay when the voltage or the impedance falls below a certain value or when the current exceeds a given value. By adding capacity and resistance a deferred response is obtained, a task difficult to solve, and requiring a thousand times stronger current, in the case of the electromagnetic relay. In this group of applications illustrated by diagrams the grid is given a fixed negative potential. In a second group of devices, intended for the protection of lines and machines, the grid at any instant is caused to take values corresponding to the current or the voltage to be controlled, including the value zero when another half cycle begins. Relays functioning on the principles of the wattmeter have been designed which depend for their operation on the phase difference between current and voltage, in another type of relay; the blocking voltage is proportional to the rate of change of the current; resonant relays or contactors have been used for protecting generators operated in parallel against sudden grounds. The ordinary thyratron is sensitive to temperature changes, so that it has been found advantageous to use argon in place of mercury. The highest voltage which these tubes will stand is 500 volts, which is sufficient for practical purposes. The tubes have a life of over 5,000 hours. See also *Electronics,* January and April, 1931.—*Revue gen. El. 17: 197-202. 1933.*

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The League's radio facilities

[G. F. Van Dissel, League of Nations] The League's station, Radio Nations, consists of two shortwave senders of 20 kw. each when used for telegraphy; 8 kw. when used for telephony at 90 per cent modulation, for waves between 14 and 100 meters. It has also at its service a 50-kw. sender for medium waves belonging in part to the Swiss Government. One of the short-wave transmitters has been supplied by the Marconi Company; it uses a multivibrator in which temperature changes produce an increase in the inductance of the coil which is exactly compensated by the decrease in capacity of the condenser. The short-wave transmitter built by the Societe fr. Radio-electrique uses a quartz controlled oscillator with temperature control. One short-wave antenna uses vertical dipoles in the Franklin arrangement; there are also groups of Telefunken antennas with horizontal dipoles (one for South America and the Far East, another for North America, 20 m. wave). The receiving station is five miles from Geneva and is provided with Bell Telephone and Telefunken equipment, including seven Telefunken receiving sets for waves between 10 and 30,000 meters to be used during times of danger. Some tubes are supplied by Philips, Eindgoven.—*Onde. el. 12: 329-352. 1933.*

✦

Clean-up of hydrogen by magnesium

[A. L. Reimann, G.E. Co. and Marconiphone Co.] A clean surface of magnesium metal at room temperature will take up one out of every one and a half million molecules of hydrogen coming into contact with the surface (contact gettering). Hydrogen is also cleaned up at the same rate when a piece of magnesium is slowly evapo-

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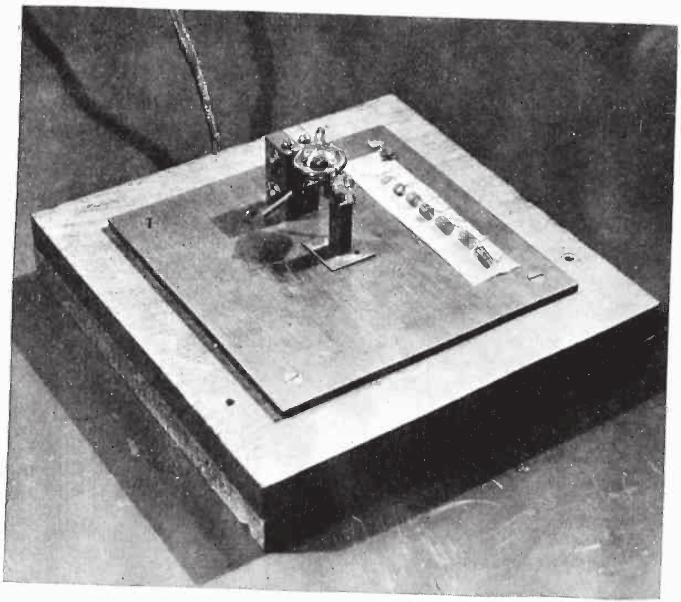
MICRO-RAY TUBE



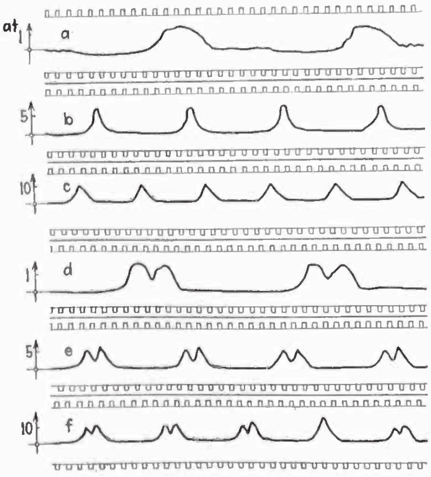
Tube and inductances for various wavelengths below one meter developed by B. J. Thompson of RCA Radiotron Laboratory

rated in the vacuum tube (dispersal gettering); magnesium absorbs hydrogen until about every sixth or seventh molecule of the mass is a hydrogen molecule. The rate of clean-up is greatly accelerated when a discharge is passed through the gas, the number of molecules absorbed being from 2 to 70 times larger than the number of ions collected at the cathode (electric discharge gettering). This effect is due to the formation of hydrogen atoms from molecular ions.—*Phil. Mag. and J. Science 16: 673-678. 1933.*

◆

Measurements of rapidly varying pressures by cathode ray tube

[J. Kluge and H. E. Linckh, German Bureau of Standards.] The improvements made in the last three or four years has transformed the cathode ray tube into a very suitable tool when used with a pressure quartz and a vacuum tube amplifier for studying rapidly varying pressures, such as occur in internal combustion engines. When the condenser shunting the two quartz plates is set to the smallest value, the sensitivity of the arrangement is about 1 volt per atm. With hundredfold amplification in the vacuum tube voltmeter circuit and a cathode ray tube giving 0.5 mm. deflection per volt it is possible to obtain 50 mm. per atmosphere. With 500 μμf in parallel with the plates, the response is reduced to 2 mm. per atm. (A similar investigation is in progress in the Mechanical Eng. Department of the M.I.T.) The equipment is manufactured by the D. S. Loewe Radio, Berlin.—*Forschung Ing. wesens, 4: 177-182. 1944.*



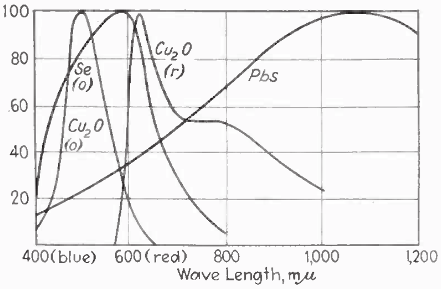
Pressure-time curves of 8 hp. internal combustion engine. Film moving 60 cm/second.

a. No load 750 r.p.m. }
b. Load 1 kw. 1550 r.p.m. } *ignition early*
c. Load 2 kw. 2500 r.p.m. }

d. No load 700 r.p.m. }
e. Load 1 kw. 1600 r.p.m. } *ignition early*
f. Load 2 kw. 2150 r.p.m. }

Barrier plane photocells

[B. Lange, Kaiser Wilhelm Institute, Berlin Dahlem.] The author (see *Electronics,* July 1932, p. 237) discusses the cuprous oxide (CU_2O) copper reverse and obverse cell (*Electronics,* October 1932, p. 312) the lead sulfide Pb. S and the selenium cell. The change of sensitivity with the wavelength can readily be made equal to that of the eye by using the selenium cell with a colored glass filter. The photocurrent furnished by the reverse CU_2O cell is proportional to the illumination up to 10,000 lux (a few microamp.) whether the external resistance be 10 or 500 ohms. The potential produced by the light is proportional to the illumination up to 2000 lux, or bright daylight (8 mv.) Selenium gives a linear response between 0 and 40 lux. The photocurrent produced in the CU_2O reverse cell increases by about one per cent for each deg. C. Selenium cells are less affected, at least near room temperature. Cesium cells in argon actually have the same order of sensitivity but a thousand times higher internal resistance. The response of commercial selenium cells slowly increases in the course of time, reaching a flat maximum; the change is the more rapid the higher the illumination. Some applications are described.—*Zeits. Instrumentenkunde 53: 344-349. 1933.*



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Grid controlled rectifier as regulator for a.c.

[P. Lenz, Research Laboratory, German G.E. Co.] The load is placed in series with the primary of a transformer with iron core; the secondary of the transformer is short-circuited through a grid-controlled rectifier. The negative grid potential determines the time during which the tube carries current in each period. Theory and experiment show that when no discharge is allowed to pass, the high resistance in the secondary reduces the current in the primary to a negligible value. When the tube carries current during the entire positive half-period, the inductance of the transformer is reduced to a small value, the iron remaining practically saturated, even during the interval in which the discharge disappears; the primary current depends upon the ohmic resistance of the load only. Even between these two extreme cases the current is approximately sinusoidal and can be gradually varied by means of the grid bias.—*Archiv. Ekeltrot. 27: 497-504. 1933.*

◆

Automatic device for the study of reverberation

[M. J. O. Strutt, Research Lab. Philips Inc.] Using improved equipment, Sabine's law is tested and modified as follows: When a source of sound is suddenly stopped, the length of the reverberation period is independent of the location of source and receiver, in halls having a volume of about 40,000 cu.ft. except when a hall with strongly absorbent walls opens into a room with strongly reflecting surfaces. In this case the duration increases gradually with the approach to the open door. In smaller rooms the law is accurate to within 10 per cent provided the volume exceeds 5,000 cu.ft. and provided that all the walls are of nearly the same nature. If this is not the case the law is satisfied when the volume exceeds 12,000 cu.ft. However, selective reverberation over a certain frequency range does not result in audible distortion of speech and music.—*Revue d'acoustique* 2: 1-26. 1933.

◆

Plate current characteristics and brightness of cathode ray tubes

[F. Hehlgans, Research Laboratory, German General Electric Company.] The cathode ray tubes (11 cm. long, 3 cm. in diameter) as used in sound picture and television work have a negatively charged Wehnelt cylinder between cathode and plate (which are 14 mm. apart) and sometimes a fourth electrode positively charged, right in front of the cathode. A fraction of the electrons passes through the plate and hits the luminescent screen of calcium tungstate. At 1,500 volts the greater part of the light emitted lies in the dark blue. When the Wehnelt cylinder is used as a grid, the plate current-grid voltage curves are entirely analogous to those of ordinary three electrode tubes filled with gas and present long straight portions corresponding to a definite value of mutual conductance and amplification factor; this is only possible because the electrons hitting the screen turn back and travel to the plate. The light output is not proportional to the plate current except over certain ranges. The fourth electrode increases the luminosity at the same plate voltage and without reducing the linear grid voltage swing. Pressures ought to lie between 1/1,000 and 1/100 mm.—*Hoch fr. u.El. Ak. 42: 45-53. 1933.*

Cross-section of electron beam and nature of gas

[E. F. Richter, Research Laboratory, German General Electric Company.] In one type of low voltage cathode ray tube the electrons are forced to pass through a positively charged diaphragm and then through a narrow cylinder, 8 mm. long and 1 mm. in diameter, forming part of the plate. With 350 volts on the plate narrow beams appear only in a very limited range of pressure for each gas. When the plate current measures between 1 and 2 ma., the pressure where threadlike beams appear lies (in thousandths of mm. mercury column) between 8 and 10 in hydrogen, 19 and 20 in helium, 4.6 to 5.4 in neon, 0.8 to 1.6 in nitrogen, 0.9 to 1.1 in argon, 0.8 to 0.9 in krypton, 0.25 and 0.30 in xenon.—*Phys. Zeits. 34: 457-458. 1933.*

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Low voltage cathode ray tube circuit

[J. Dantscher, Research Laboratory, German General Electric Company.] The tube works with 400 volts on the plate and is intended for the study of periodic currents or potentials. The time axis is produced by means of a condenser C charged through a vacuum tube (saturation current i) and discharging whenever the grid bias is reduced to e, across a three electrode tube containing inert gases. Part of the potential to be recorded is introduced into the grid circuit of the gas-filled tube in order to obtain synchronization. The frequency of the time sweep circuit is given by $i/(E_1 - E_2)C\ (1+a)$, where a is the ratio of the discharging period to the time necessery for charging E_1 the starting voltage and E_2 the lowest plate potential at which the gaseous tube runs; it is clear that the frequency can be varied between wide limits, normally between 0 and 30,000 cycles, but with gaseous tubes of special design up to 250,000 cycles per sec.—*Zeits. techn. Phys. 14: 337-341. 1933.*

✦

Cesium atoms in cesium, cesium-oxide on metal cathodes

[J. H. DeBoer and M. C. Teves, Philips' Research Laboratory, Eindhoven]. When light strikes a surface consisting of a support of pure metal covered by a cesium oxide or salt layer (calcium fluoride) which holds alkali or alkaline earth metals, light liberates electrons from the adsorbed atoms. The adsorbed atom is more readily ionized than a free atom on account of the greater energy with which the ion will be absorbed, the excess being made available for renewing the electron (0.95 volt). The same is true of thermionic emission; the work function is only 0.6 volt.

When on the other hand a small number of atoms of alkali or alkaline earth metals are directly held by the metal surface, then the adsorbed atoms lower the work required for dislodging electrons from the metal surface itself. *Zeits. f. Phys.* 83: 521-533. 1933.

✦

Three-centimeter waves in cobalt research

Production of electrical waves of the order of 3-meters has made possible investigation of the magnetic properties of cobalt for the first time according to a dispatch from California Institute of Technology where Dr. G. W. Potapenko announces that he has (1) measured the magnetic properties of cobalt, one of the three existing magnetic substances, for the first time in the high frequency range, (2) discovered that cobalt is vastly superior to iron and nickel, the only magnetic metals now used for cores of electro-magnets in high frequency technique, thus giving the electrical industry 50 per cent more material to work with in its most essential and most basic department, and (3) verified predications made by Dr. Fritz Zwicky regarding the relative sizes of units of magnetic structure, in iron, nickel and cobalt.

Cobalt, according to Dr. Potapenko, has the unsuspected quality of a steady decrease in its magnetic attraction as frequency is increased. To make this discovery, the physicist generated a frequency of 10,000,000,000 cycles with oscillator tubes. (See cover, this issue of *Electronics.*)

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Notes on dual-band receiver design

[*Continued from page 301*]

The effect at the low frequency points was less noticeable because on the long-wave band the bankwound coil was only a small part of the total inductance.

Figure 3 illustrates a commonly used carrier signal tuned circuit. It will be noticed that trimming condenser C which is used to track the long wave sections, is connected across the long-wave part of the secondary. This scheme is the simplest and provides maximum stability. The equation for the voltage across C_1 which is the voltage presented to the next grid is as follows:

$$e = \frac{E}{\omega L_1 - \dfrac{1}{\omega C_1} - \dfrac{\omega L/\omega C}{\omega L - \dfrac{1}{\omega C}}}$$

where E is the impressed voltage.

Inspection shows that e will be a maximum at two frequencies: when the whole circuit is tuned to resonance, and when L_1, C and C_1 are resonant at some higher frequency at which the reactance of C_1 is negligible with respect to the reactance of L.

If the primary is also coupled to the long wave section of the secondary, the equation for voltage across C_1 from this source is:

$$e = \frac{\left[\dfrac{E_1}{\omega L - \dfrac{\left(\omega L_1 - \dfrac{1}{\omega C_1}\right)\dfrac{1}{\omega C}}{\omega L_1 - \dfrac{1}{\omega C_1} - \dfrac{1}{\omega C}}}\right]\left[\dfrac{-\left(\omega L_1 - \dfrac{1}{\omega C_1}\right)\dfrac{1}{\omega C}}{\omega L_1 - \dfrac{1}{\omega C_1} - \dfrac{1}{\omega C}}\right]\dfrac{1}{\omega C}}{\omega L_1 - \dfrac{1}{\omega C_1}}$$

where the first term in the numerator is the circuit current, the second term is the effective impedance of L_1, C and C_1; the product of these terms is the voltage across L_1 and C_1. Inspection of this equation shows three possible resonant points; when the whole circuit is resonant, when L_1 and C_1 are resonant, and when L_1, C and C_1 are resonant.

It is therefore a relatively easy matter for oscillator harmonics to cause spurious responses. The remedy is to connect the trimming capacity so that on the long wave band it is in shunt with the tuning condenser in Fig. 4.

These notes have only touched the surface of the problem, as anyone who has worked on such designs will realize. It is hoped, however, that some of the points covered will help practical designers.

+ NEW PRODUCTS

THE MANUFACTURERS OFFER

Dual-output three-stage amplifier

A 13-WATT DUAL-CHANNEL, dual-output, class B, three-stage amplifier, universally powered for either sound-truck or auditorium public-address-system operation, is a new product of the Coast-to-Coast Radio Corporation, 121 W. 17th St., New York City. Operable from either 110-volts a.c. or 6-volts d.c., this outfit opens up a new and profitable field for portable, mobile, temporary and permanent installations.

When the amplifier is being powered from a storage battery, it employs the new RCA-Victor vibrator-type converter-rectifier. The whole unit is silent and fool-proof, and operates with high efficiency. A combination 6-volt and 110-volt phonograph motor is also available to serve as an accessory.—*Electronics.*

Sensitive scale

A NOVEL SCALE FOR WEIGHING very small quantities of chemicals, parts, etc., has been developed by the Continental Electric Company of St. Charles, Ill. So delicate is the instrument that some models will weigh a pencil-mark on a piece of paper. This Acrascale, as it is called, is suitable for the laboratory, and also for the factory where rapidity and simplicity of weighing are important. The Acrascale is made in five different ranges and sensitivities, from 0.15 mg., with 0.05 mg. sensitivity; up to 0-1000 mg., with 2 mg. sensitivity. Each model has two ranges, one twice the range of the other. Prices $12 and $15.—*Electronics.*

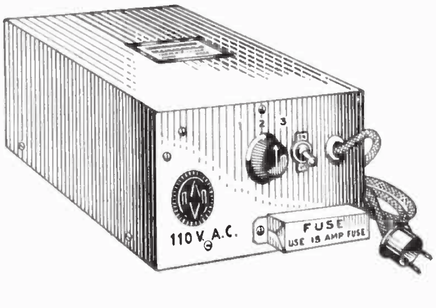
Antenna system

A NEW TYPE OF antenna feeder system, which matches the impedance of the transmission line to that of the antenna without the use of inefficient coupling devices, has just been developed for the E. F. Johnson Co., Waseca, Minn., manufacturers of radio transmitting equipment, by Ralph P. Glover, consulting electrical engineer.

The system makes use of the well known impedance-matching properties of the quarter-wave line, which is inserted between a Hertzian doublet transmitting antenna and a main transmission line of any convenient length. The quarter-wave section is constructed of thin-walled copper or aluminum tubing and is suspended from the center of the antenna. The tubes are closely spaced, the actual spacing being that which results in a characteristic impedance which is the geometric mean between the antenna impedance of about 75 ohms (for a half-wave doublet) and the main-line impedance, which commonly lies between 400 and 600 ohms. The improvement is of the order of 3 decibels. —*Electronics.*

Converter, 32 to 110 volts

ELECTRONIC LABORATORIES, 122 West New York Street, Indianapolis, Ind., have put on the market an electronic converter for producing 110-volt alternating current from 32-volt direct current, such as is used in farm-lighting systems. This apparatus makes possible the use of standard alternating-current home devices such as vacuum sweepers, juice extractors, neon signs, radios, etc., on lines which would otherwise require more expensive special appliances for the supply voltage. Thus a farm-plant owner may purchase home appliances that can later be used on central-station service. These converter units are made in 100 watts and 200 watts output. There is also a converter from 110 volts direct current, to 110 volts alternating current.—*Electronics.*



Amplifier for deaf

THE NEW MODEL HA1 of the hearing-aid devices produced by the Universal Microphone Company, Inglewood, Cal. (two-stage amplifier, using two 230 tubes, and standard dry-cell batteries) now carries optional equipment of ten single headsets.

The device thus becomes adaptable for hard-of-hearing people in churches, theaters, schools, institutions and other places. The unit itself is placed near the speaker or music, with a line to the audience seats.

Manufacturers of the apparatus suggest individual volume control to each head-set. By using a telephone jack, the earphones can then be plugged in. The use of standard large-size dry batteries allows consistent long-time use at low battery up-keep.—*Electronics.*

Resistor characteristics

THE ERIE RESISTOR CORPORATION, Erie, Pa., announces that it has improved the voltage characteristics of its complete line of resistors and ignition suppressors from 50 to 60 per cent.

This marked decrease in the drop in resistance value at maximum rated voltages has been effected by advancements in manufacturing technique and the development of a new and highly efficient combination of raw materials.

This new "mix" does not in any manner adversely affect the other electrical and physical characteristics of Erie resistors.—*Electronics.*

Experimental "electric-eye" unit

J. THOMAS RHAMSTINE, 500 East Woodbridge Ave., Detroit, Mich., has put on the market a simplified "electric eye" relay unit intended primarily for experimental, educational and entertainment use, but also available as a basic unit for many applications in commercial service. The unit can be operated by a simple 110-volt lamp, or a focusing flashlight, or by infra-red illumination to produce an invisible beam. The experimental outfit is priced complete at $8.95.—*Electronics.*

Balsa-wood sound insulation

SOUND INSULATION, room lining and baffle panels for broadcasting and sound-recording studios, loudspeakers, soundproofing, isolation pads, etc., for which Lata balsa wood is adapted, are now offered by the Balsa Wood Company, Inc., Brooklyn, N. Y.

Microphotographs of this material show its minute, flexible-walled cells, filled with dead air, but free of lignification, thus providing a perfect cushion against wave passage, whether of sound or vibration. In addition its strength, as evidenced by its ability to withstand compression without loss of resiliency, makes balsa wood a strong supporting material.—*Electronics.*

Extremely light-weight headphone sets

The Trimm Radio Manufacturing Company, 1528 Armitage Ave., Chicago, Ill., has brought out its Featherweight headphones, which it declares to be "America's most highly developed headset." The net weight is four ounces, complete with two phone units, 5-ft. cord, and head-band. Magnets are of the best grade Cobalt steel. These Featherweight headphones are furnished in any resistance desired, from one ohm to 2,400 ohms for each unit. The 4,800-ohm phone is recommended for short-wave reception. Single unit Featherweight phones are also available with spring bands and with lorgnette handles for group installation in churches, theatres and lodges.—*Electronics.*

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Vacuum-contact relays

Ward Leonard Electric Company, Mount Vernon, N. Y., has a line of vacuum-contact relays for applications where non-arcing, instantaneous and positive contact in the electric circuit are essential features of the switching device.

The vacuum contact is mounted in the metal base and fully protected from accidental damage.

These relays operate on a small amount of current, controlling power circuits as high as 6 amperes continuously or 8 amperes intermittently, either a.c. or d.c. (non-inductive) at 110 or 220 volts.

The base measures 1½ in. by 4 in., and depth without enclosing cover is 1¾ in. The relays are obtainable single and double pole, normally open, and normally closed.—*Electronics,*

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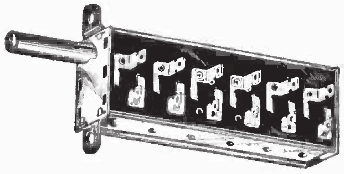
Weather-proof dry disk rectifiers

Mallory-Elkon rectifiers manufactured by P. R. Mallory & Company, Indianapolis, Ind., are now sealed for protection against atmospheric conditions, making these compact, durable units now weather, water and salt-spray proof which gives their users a very decided advantage. Additional recommendations are simple and rugged construction, the absence of lead "cushion" to cold flow, and the elimination of polarizing surfaces to cause leakage and backward rectification. These "bone dry" rectifiers have a high capacity for their size and are demonstrating their value on a large variety of d.-c. apparatus such as battery chargers, electroplating units, electro magnetic devices, speaker and signaling systems, a.c.-d.c. radios, etc. — *Electronics.*

Multi-polar rotary switches

A new rotary, snap-action switch, applicable to a wide variety of new circuit requirements, has been developed by H. H. Eby Manufacturing Company, 21st and Hunting Park Ave., Philadelphia, Pa. The frame is of corrosion-proof steel, and phenolic insulation is used. Suggested uses of the switch are for two-band radio receivers, universal receivers, low-powered transmitters, test equipment, laboratory apparatus, signaling apparatus, and electronic devices of various kinds. To insure low contact resistance, high-grade phosphor-bronze springs, silver-plated, are employed. The switches are obtainable with one to six poles, single or double-throw.—*Electronics*



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New Argus prices

The A.M.I. Distributing Company announces new prices on photo relay units. These prices are: The Argus photo-relay kit $39.50, the light source $13.50 and the infra-red filter $10.50.

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Thermal delay relays

The Burling Instrument Company, 185 Market St., Newark, N. J., is agent for the Thomas A Edison thermal delay relays and other relay controls. Such thermal relays are operated by the thermal expansion of metals, a wire, or a bi-metal arm; for this reason definite and secure contact is made with both alternating current and direct current. A relay controlling 1,000 watts, a.c. or d.c., is made to operate with a 30-second delay at 15 watts. A relay designed to delay one minute would operate on approximately 12 watts. Such relays are priced at $7.50.—*Electronics.*

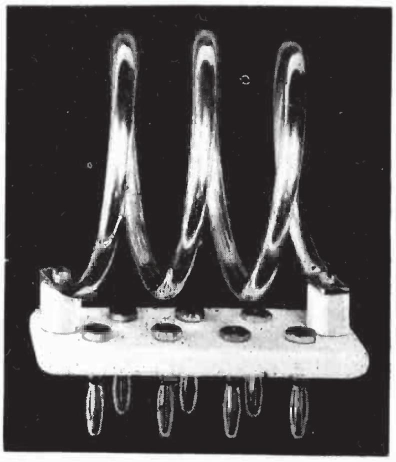
✦

Sensitive relay

A rugged and sensitive relay especially suitable for photoelectric application has been announced by the Kurman Electric Company, 241 Lafayette St., New York City. This relay is economical in first cost and in operation. The K-1 relay requires .03 watts for positive operation, has coin silver contacts rated to carry 1 amp. non-inductive load, has sharp drop out at approximately 60 per cent of the operating current value. Can be supplied to operate from .001 amps. at 19 volts to .23 amps. at .083 volts.—*Electronics.*

High frequency inductances and mounting base

Premier Crystal Laboratories, Inc., 63 Park Row, New York City, have just announced that they are manufacturing a complete set of coils and mounting base, which are especially designed for those desiring the utmost in high frequency equipment. Coils are machine wound of high conductivity, heavy wall dehydrated copper tubing. They are chromium plated and polished over a heavy nickel plating, thus presenting a smooth, durable, bright finish which adds not only to the efficiency, but also to the appearance of any transmitter in which these coils are employed. Coils are supported on two glazed Isolantite spacer studs on a glazed Isolontite plug strip, the latter being equipped with seven spring type plugs which allows convenient circuit arrangement, permitting accurate mid-tapping for neutralized or push-pull circuit, grounded center for parallel feed, grid and plate coupling taps as well as neutralizing taps which may be experimentally determined and then permanently fixed. This method of using plug-in coils is convenient and extremely rapid when making changes from one band to another.



The complete set comprises four coils and a base mounting. The coils are designed to cover a range from 6 to 60 megacycles. Send for Premier's Bulletin No. 101 which completely describes above coils, base mounting and various other products for frequency control.—*Electronics.*

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Manufacturers' bulletins and catalogs

Metallascope—The Fisher Metallascope for locating underground metal bodies, referred to on page 252 of September *Electronics*, is made by Gerhard R. Fisher, Palmer Building, 6362 Hollywood Boulevard, Hollywood, Calif.

Resistors—The Muter Company, 1265 South Michigan Ave., Chicago, Ill., has issued new catalog inserts covering its manufacturer's specification resistors, fixed resistors, and wirewound resistors, for use in the Muter general and technical catalogs.

Photo-cell characteristics — Characteristics of DeVry photo electric cells complete with graphs showing current response, voltage, etc., are given in a circular issued by Herman A. DeVry, Inc. 1111 Center St., Chicago, Ill.

Illumination control

Through error an item in September on elevator leveling system was illustrated with an illumination control device. There is no connection between the two units, of course!

The illumination control unit is made by Westinghouse and is called the Photolux. Obviously it is a photoelectric device and automatically turns on and off lights in accordance with variations in daylight illumination in schools, work shops, store windows, offices, airway and navigation beacons, etc., etc.

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Piezo phonograph reproducers

In place of the former heavy electromagnetic pick-up with great mass and damping in order to reproduce the lower frequencies and producing severe wear on the record the new piezo-astatic reproducer developed by the Astatic Microphone Laboratory, Youngstown, Ohio, has the five advantages of light weight, uniform response, free damping, non-resonance, and non-magnetic character. A small crystal element is coupled to an extremely light stylus chuck (lighter than the average phonograph needle). Owing to the flexibility of the crystal, and the small mass of the chuck, little mechanical damping is required, which results in practically uniform response over the whole audio range.—*Electronics.*

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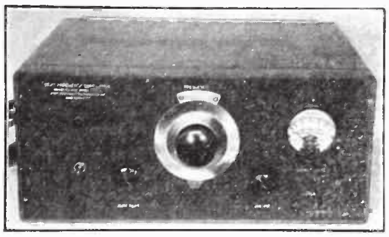
Wire strippers for insulated wires

Motor-driven strippers for insulated wires are provided by the Wire Stripper Company, 357 Erie Building, Cleveland, Ohio, which manufactures several different types for different purposes. Its Speedcraft knife-type stripper handles most kinds of solid or stranded wire, single or multiconductor cord or cable, insulated with rubber, composition, braid, fabric, asbestos, etc. The Speedcraft stripper makes a clean cut of the insulation and neatly twists loose strands.

For more difficult and unusual wire-stripping jobs, a brush type of stripper is supplied. These strippers use wire brushes to remove the insulation, and each machine is driven by a one-half horsepower motor. The stripper is provided with easy adjustment, safety guards, and suction exhaust of insulation. The brush principle is found best suited for enamel and cotton insulation, coil or armature leads, square or flat conductors, and other insulations hard to strip. Special provision is made for stripping insulation in the middle of a wire, or for removing insulation altogether in salvaging defective wire.—*Electronics.*

Portable beat-frequency oscillator

The Wireless Egert Company, 179 Varick St., New York City, has produced a new compact, accurate and portable beat-frequency oscillator, entirely a.c. operated. This may be obtained with a calibration chart or with a directly calibrated dial mounted on the condenser shaft. An ingenious arrangement of a variable condenser and an r-f transformer reflects the original capacity of the variable condenser to many times its ordinary value. To reduce harmonics, a very heavy tank circuit is used. Heater-type tubes insure ruggedness. A separate and entirely isolated B supply fits into a rear compartment of the oscillator. With power supply the instrument weighs 30 pounds. The instrument has high frequency stability, and its calibration is accurate and within 2 per cent at frequencies above 40 cycles. The price, complete less tubes, is $155.—*Electronics.*



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Amplifier for oscillograph and laboratory use

For use with cathode-ray oscillographs and for general laboratory purposes, the Allen B. DuMont Laboratories, Upper Montclair, N. J., have developed a high-quality alternating-current operated amplifier. It is extremely important that an amplifier for this service have elements of frequency response, general stability and linearity, together with freedom from phase shift which is quite unnecessary in ordinary units.

This DuMont type 136 amplifier is a three-stage unit which has a response curve flat between 10 and 100,000 cycles, and there is little phase shift in this range. Its output of 50 volts r.m.s. is sufficient for the deflection of the usual cathode-ray tube, at which output there is no non-linearity.

This amplifier may be inserted into any ordinary communication circuit for voltage and waveform measurements by virtue of its high input impedance. At the same time its output impedance is sufficiently low to avoid ill effects due to the impedance of cathode-ray tube deflecting plate systems and to allow its use with other indicating devices.—*Electronics.*

High-voltage condensers

Reduction in cubic volume and weight by more than 50 per cent as compared with previous types, a non-inflammable impregnator permitting use in hazardous locations, operation at high ambient temperatures destructive to former ordinary types, and a leakage resistance and power factor change far less at high temperatures than with types currently employed, are features of the new pyranol impregnated high-voltage filter condensers being introduced by the Cornell-Dubilier Corporation, 4377 Bronx Blvd., New York City.

The Cornell-Dubilier pyranol impregnated condensers are available in three standard direct-current working voltages and the following range of capacities: 1,000-volt, 1 mfd. to 10 mfd.; 1,500-volt, 1 mfd. to 6 mfd.; and 2,000-volt, 1 and 2 mfd. These units can be operated continuously at voltages up to 10 per cent above rating.—*Electronics.*

✦

Sprayed metal

The Metals Coating Company of America, 495 N. Third St., Philadelphia, Pa., has developed instruments for sprayed molten metal coatings.

Sprayed metal coatings applied with the MetaLayeR are used to:

Provide protection against atmospheric corrosion on chemical action.

Provide protection against the deteriorating effects of exposure to high temperatures.

Apply electrical contacts and to develop conducting or resistance coating on conducting or insulating materials.

Alter shapes or add dimension or weight to worn or mismachined (undersized) parts with micrometer accuracy.

Develop unique and attractive decorative effects. Sprayed metal coatings render inflammable materials flame proof and fire resistant.

Join metallic to non-metallic materials. —*Electronics.*

BRITISH PATENTS
IN THE FIELD OF ELECTRONICS

Electron Tube Applications

Manufacture of printing plates, etc. Method of producing representations by applying a gradually decreasing negative voltage to the grid of a gaseous discharge tube during regularly spaced predetermined intervals of time, projecting light onto several small areas of the original in a scanning operation and causing a cutting tool actuated by the plate current to cut out of a plate the desired subject. J. W. Dalton, Wimbledon, London. No. 391,838.

Cathode ray tubes. A thin fluorescent screen layer for a cathode ray television tube made by depositing particles of screen material upon a surface from suspension in a liquid, for example by gravity, the size of the particles being such that they can adhere to the surface in the absence of a separate binding material, for example pulverized material screened through a mesh 270 per inch. The liquid is subsequently removed as by draining off or by evaporation. The screen may be associated with a conductive layer or be rendered conductive in alternate ways. Zinc sulphide, zinc silicate (willemite) or calcium tungstate may be used for the screen material, and water or alcohol for the suspending liquids. Other interesting parts of the process are outlined in this patent. R.C.A.-Victor Co. No. 391,887.

A feedback system in which photocell currents are amplified by an energy feedback between the cell and the output of the amplifier. R. R. Haugh, British Thomson-Houston Co. No. 394,121.

Modulating system. A modulating circuit particularly intended for picture telegraphy or television, comprising two tetrodes with a carrier wave applied in phase opposition to corresponding grids and with the modulating potentials applied to another grid of one of the group to upset the carrier balance in the joint plate circuit. M. Artzt, Marconi Co. No. 394,186.

Television system. Apparatus for producing a saw-tooth potential for use in producing a time deflection in a cathode ray oscillograph and for scanning in television apparatus. K. Schlesinger, Berlin, Germany. No. 394,476.

Sound recording system. Method of connecting a light sensitive cell in series with the primary of a transformer, the secondary of which feeds the grid circuit of an amplifier. B. Kreuzer, R.C.A. No. 394,822.

Smoke protection. Use of a light sensitive cell to generate an e.m.f. when in full light in an installation for protecting against smoke or dust. A. J. Stevens, London. No. 394,853.

Light signal system. Method of transmitting television by modulating radio frequency current. E. F. W. Alexanderson, G. E. Co. No. 395,242.

Radio Circuits

Television receiver. Image color due to the nature of the Neon tube or screen is compensated by projecting on the screen unmodulated light, complimentary to the color of the image. J. C. Batchelor, Marconi Co. No. 392,869.

Superhetrodyne circuit. Second channel interference is reduced by connecting the grid of the first tube to the aerial both through the tuned circuit and also through a condenser. E. K. Cole, Ltd. No. 389,081.

Automatic volume control. Several patents granted to Telefunken on various methods of automatic volume control. No. 393,415; No. 393,421; No. 393,472. In the first two, logarithmic rectifiers seem to be essential, that is the relation between the input voltage and the output current is logarithmic. Low-frequency output is proportional to the degree of modulation of the input high-frequency wave and independent of its average amplitude. Rectifier stage in No. 393,415 may include a photoelectric cell actuated by a light source modulated by the signal input as the current output in such a cell is approximately a logarithmic function of the light strength or a gas discharge tube may be utilized as a rectifier by virtue of its saturation phenomenon. In the second patent a rectifier having ordinary characteristics is associated with a subsequent amplifier stage in such a manner that the combined rectifier and amplifier exhibit the required characteristics. In the third patent a grid bias control voltage is arranged to be proportional to the actual received signal, that is a voltage which has not been subjected to gain control and the amplifying tube controlled is free from anode retroaction and has a characteristic which is inversely proportional to the applied bias.

Superheterodyne receivers. A receiver for ultra-short waves using an oscillator of the Barkhausen-Kurz type. The intermediate frequency amplifier is of the super-regenerative type and operates at a high frequency. R. W. George, Marconi Co. No. 394,267.

Class B amplifier. Tubes with a high amplification factor and high internal impedance are used in audio frequency or other power amplifiers with low impedance in the input and output circuit, distortion being prevented by allowing grid current to flow. Valves are driven to the limit of their emission. L. E. Barton, Marconi Co. No. 395,277.

FIG.2.

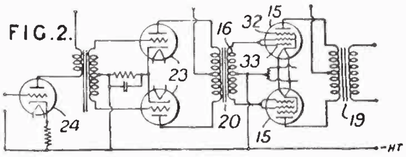


FIG.3.

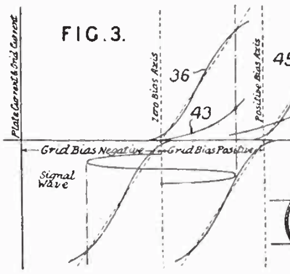
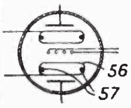


FIG.6.



Noise suppression circuit. A receiver incorporating A.V.C. The loud speaker is arranged to be inoperative when the signal is below a predetermined value. R. S. Holmes, British Thomson-Houston Co. No. 395,327.

Oscillator circuit. The local oscillator is provided with mixed magnetic and capacity back couplings whereby its output frequency characteristic over the tuning range may be arranged to compensate for or may be otherwise correlated with the amplification frequency characteristic of the radio frequency amplifier. The oscillator is substantially free from harmonics. W. A. MacDonald, Hazeltine Corp. No. 394,364.

FIG.1.

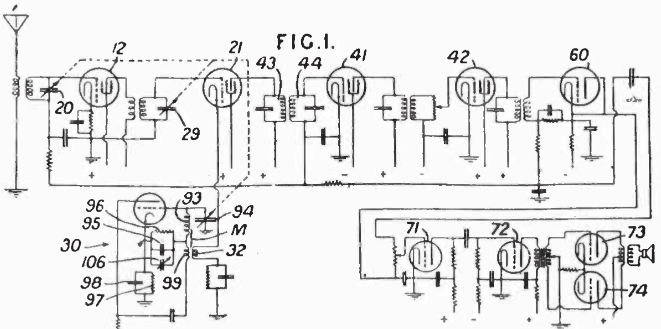


FIG.2.

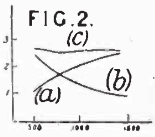
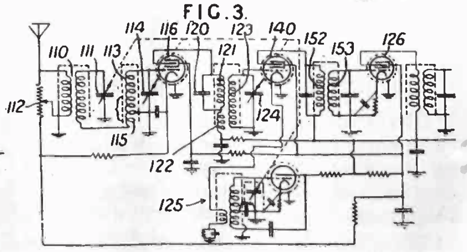


FIG.3.



Patent No. 394,364 to W. A. MacDonald on oscillator circuits for superheterodyne receivers

Victron

THE NEW VICTRON, emerging from the laboratory an outstanding achievement in the development of plastic dielectrics now takes its place, commercially, for service in the electronic industries. Far eclipsing any other insulator of its kind in point of electrical loss in the upper range of the communication frequency spectrum, Victron insulating compositions make an important and timely contribution toward the advancement of communications.

No longer need the industry accept plastic dielectrics which have failed to keep pace with the rapidly growing art of modern electrical communications. The new Victron may be molded to specifications or supplied in the form of sheets or tubes which may, of course, be fabricated locally like any other resinous insulator.

Victron has many uses in the construction of devices where the highest circuit efficiency is required. It is particularly well suited to the manufacture of such components as inductance supports for low powered transmitters and high frequency receivers, vacuum tube bases which may be molded with prong inserts, tuning condensers and band change switches. Sheet stock for panels, terminal mountings, sub-bases and a great variety of other applications may be produced in the new Victron with the assurance that every part is insulated for maximum circuit efficiency.

Victron is a product of the laboratories and factories of the Naugatuck Chemical Company and the United States Rubber Company, and is distributed exclusively by the Dielectric Products Company.

PROPERTIES

POWER FACTOR
.08%—.2%*

DIELECTRIC CONSTANT
3.0—4.0

TENSILE STRENGTH
4,000—6,000
lbs./sq"

TRANSVERSE STRENGTH
9,500—10,000
lbs./sq"

*Power Factor determined at 1500 KC or above. Value depends upon composition, temperature and frequency.

DIELECTRIC PRODUCTS COMPANY
11 PARK PLACE • NEW YORK, N.Y.

ANSWERING TODAY'S NEEDS FOR CATHODE-RAY TUBES

AND ASSURING AVAILABILITY FOR FUTURE RENEWAL PURPOSES

FOR a number of years the laboratory of the RCA Radiotron Company has been engaged in an intensive research and development program on cathode-ray tubes. Involving an unusual amount of production experience on cathode-ray types, this program has emphasized the same thorough and painstaking attention to detail that characterizes the development of receiving types of RCA Radiotrons.

The results of this work are now made available in four cathode-ray tubes. These are supplemented by two types—one a rectifier for high-voltage supply, and the other a triode, gaseous type, for sweep-circuit operation.

These designs have been carefully chosen to meet the diversified needs of oscillograph application.

Important Features

1. QUALITY. RCA Cathode-Ray Tubes are manufactured to laboratory standards of precision. Comprehensive tests have demonstrated their excellent life performance.

2. AVAILABILITY FOR RENEWAL. The RCA Monogram is your assurance that these designs are standardized and will be available when required for renewal purposes.

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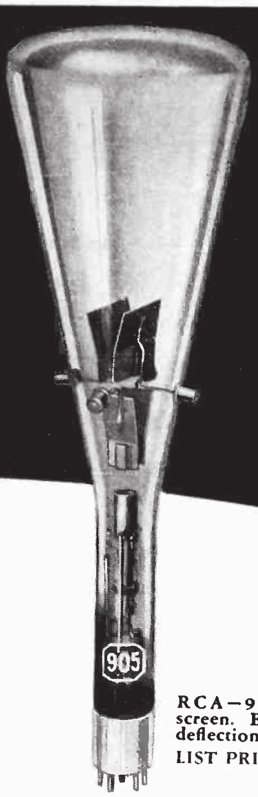
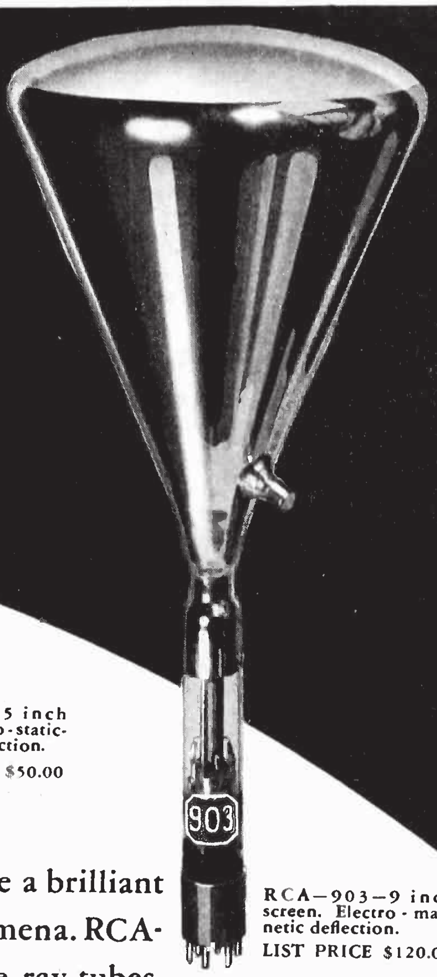
RCA—906—3 inch screen. Electrostatic deflection.
LIST PRICE $18.00



RCA—905—5 inch screen. Electro-static deflection.
LIST PRICE . $40.00

RCA—904—5 inch screen. Electro-static-magnetic deflection.
LIST PRICE . $50.00



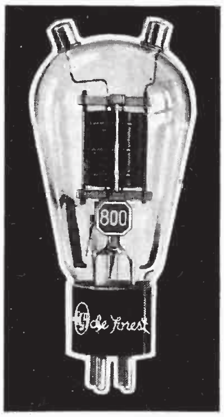
RCA—903—9 inch screen. Electro-magnetic deflection.
LIST PRICE $120.00

4 CATHODE-RAY TUBES . . .

of the hot-cathode, high-vacuum type. These tubes provide a brilliant luminous spot capable of following high-frequency phenomena. RCA-878 and RCA-885 are new tubes for use with the cathode-ray tubes.

RCA—878—A high-voltage, high-vacuum rectifier.
LIST PRICE $11.00

RCA 800 • ANOTHER LABORATORY ACHIEVEMENT



The RCA-800 is a new transmitting tube designed primarily for use in amateur transmitting stations. Capable of delivering its full output at frequencies up to 60 megacycles, the RCA-800 is an example of tubes developed by the RCA Radiotron Laboratory to meet the requirements of specialized applications.

RCA-800 . . List Price . . $\$10^{00}$

For additional information write to
De Forest Amateur Radio Division
RCA Radiotron Co., Inc.
Camden New Jersey

RCA—885—A gaseous-type triode, suitable for sweep-circuit control.
LIST PRICE $2.00

For additional information write to Engineering Department

RCA RADIOTRON CO., INC.

HARRISON NEW JERSEY

A RADIO CORPORATION OF AMERICA SUBSIDIARY

4 Decisive Reasons for equipping YOUR auto radios with S.S.WHITE FLEXIBLE SHAFTS

1- A SUPERIOR SHAFT, EXPRESSLY DEVELOPED FOR AUTO RADIOS

S. S. W. Flexible Shaft No. 150L53 originated and developed by S. S. WHITE for remote control of auto radios, is characterized by minimum torsional deflection, and deflection is equal for either direction of rotation. When properly applied, deflection is virtually eliminated and this shaft provides both tuning and volume control that is as effortless and accurate as a direct connection.

An S. S. W. Flexible Shaft controlled set can be easily installed in any car, permitting wide latitude for locating receiver in most favorable position with respect to avoiding electrical, structural and physical interference. Besides, it is SAFE, for it places the control directly under driver's hand where he can tune without shifting position or taking eyes off the road.

2- A TRIM, SMALL-DIAMETER CASING

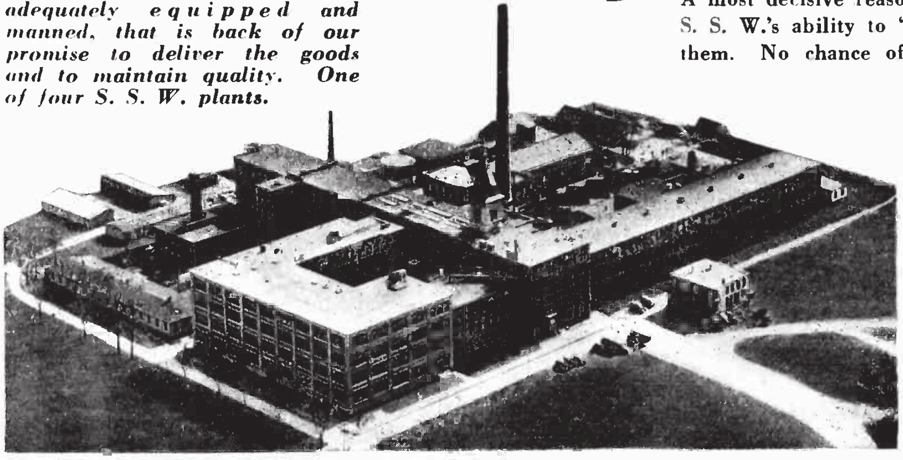
Flexible Metallic Casing No. 170A1 was also originated by S. S. W. specifically for auto radio applications. With an outside diameter of only .255", just a shade over a quarter inch, it makes possible a neat, inconspicuous installation.

3- USED ON LEADING AUTO RADIOS AND SEPARATE CONTROL UNITS

PHILCO, RCA VICTOR, MOTOROLA, CROSLEY, WELLS-GARDNER, MAJESTIC, FADA, UNITED MOTORS, UNITED AMERICAN BOSCH, PIERCE-AIRO, COLONIAL, STROMBERG-CARLSON — these are just a few of the many set manufacturers using S. S. W. Shafts, while control unit manufacturers include DE JUR, CROWE, UNITED SCIENTIFIC, ADVANCE, F. W. STEWART. Realizing the importance of smooth acting and accurate tuning controls, they demanded the best in shafts.

4- YOU ARE SURE OF DELIVERIES

A most decisive reason for using S. S. W. Shafts and Casings, is S. S. W.'s ability to "deliver the goods," when and as you need them. No chance of your production being held up, or of a falling off in quality of shafts, when demand is at its peak. S. S. W. has the facilities, the organization and the resources to meet all demands without sacrifice of quality.



Here is the Staten Island plant, adequately equipped and manned, that is back of our promise to deliver the goods and to maintain quality. One of four S. S. W. plants.

●

WRITE FOR QUOTATIONS

on your requirements. SAMPLES furnished to set and control unit manufacturers on request.

●

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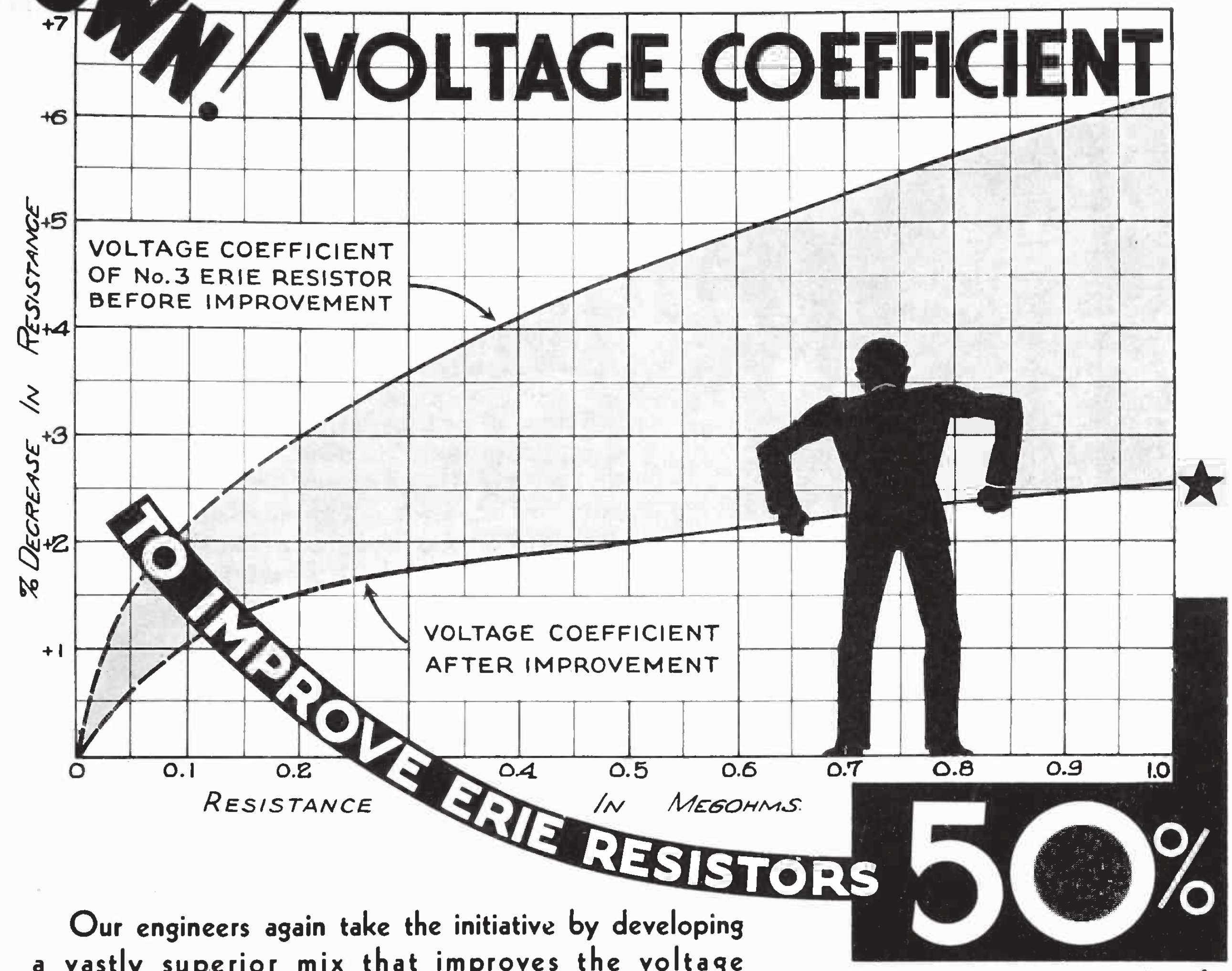
The S. S. WHITE Dental Mfg. Co.
INDUSTRIAL DIVISION
Knickerbocker Building New York, N. Y.

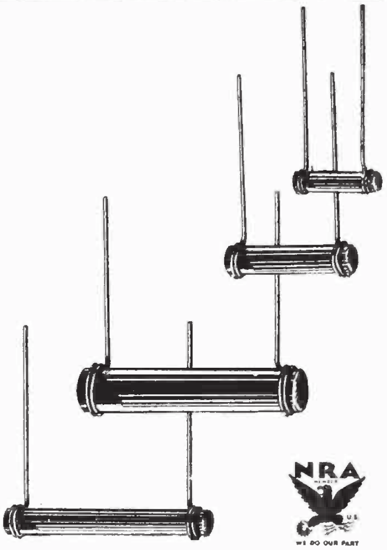
DOWN! comes the VOLTAGE COEFFICIENT



Our engineers again take the initiative by developing a vastly superior mix that improves the voltage characteristics of Erie Resistors 50% and more.

In the above graph of the No. 3, ½ watt, Erie Resistor the improvement between the former and present types is indicated by the area between the two voltage coefficient lines. For example, on the 1.0 megohm resistor the voltage coefficient at 350 volts has been reduced from 6.25% to 2.55% --a gain of over 59% . On higher resistance values the improvement is correspondingly greater.

Find out for yourself how much better these new Erie Resistors really are. A letter to us will bring you a complete set of samples to test in your own laboratory.



ERIE RESISTOR CORPORATION

ERIE, PA.

Factories in **ERIE, PA.-TORONTO, CANADA-LONDON, ENG.**

Resistance Troubles? ... try AQUADAG*

REG. U. S. **dag** PAT. OFF.
COLLOIDAL GRAPHITE PRODUCTS

The illustration shows the manner in which the concentration of the graphite on the strip may be varied in order to obtain an even taper.

Send for Technical Bulletin B11

Colloidal-graphited water has the ability to form on solids, coatings of graphite which are homogeneous, chemically inert and electrically conducting.

These characteristics prove their worth when "Aquadag" is used in connection with the coating of resistance sectors for volume and tone controls. The ease of application and simplicity of control makes this product an ideal material with which to work.

*REG. U. S. PAT. OFF.

ACHESON OILDAG COMPANY
PORT HURON, MICH.

SYNTHANE
Laminated Bakelite

Dependable Uniformity in Electrical and Mechanical Properties

DIELECTRIC STRENGTH • LOW WATER ABSORPTION
STRUCTURAL STRENGTH • LOW SURFACE LEAKAGE
CLEAN PUNCHING • MACHINEABILITY
IMPACT STRENGTH • APPEARANCE

SYNTHANE
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OFFICES IN PRINCIPAL CITIES
Sheets, Tubes, Rods, Fabricated Parts
Silent, Stabilized Gear Material

To I.R.E. Members

A Message

YOU are striving constantly to secure the best possible performance in the sets you design.

What are your variable and fixed resistor problems?

Won't you let us help you solve them with experience gained by more than twenty-five years of development and manufacture of quality carbon products?

More than a year ago we gave you a molded carbon volume control.

Many engineers have given this control every test in the book . . . and a few more besides.

They said it was good, then proved it by using it. You'll find it now in most of the best sets.

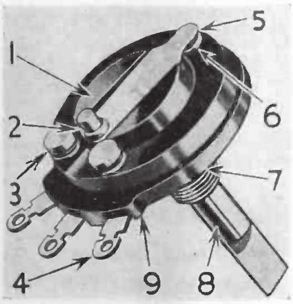
The same molded carbon element makes an equally good tone control.

And we can supply you with fixed carbon resistors that are, and have been for some time, the standard of comparison in both radio and electrical fields.

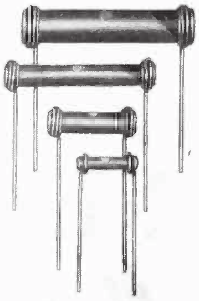
We will be glad to prove these statements. Write us.

STACKPOLE CARBON COMPANY

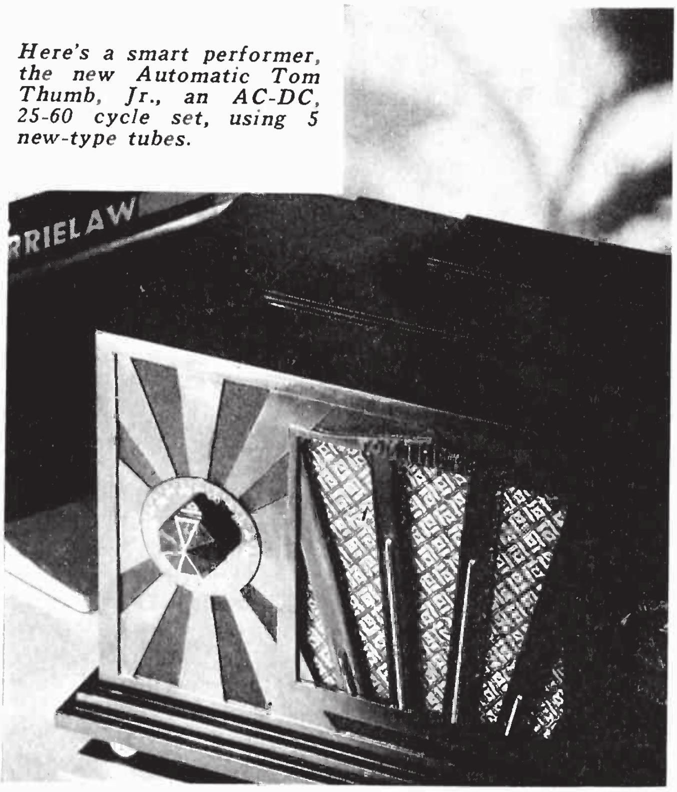
ST. MARYS, PENNA.



Stackpole Molded Carbon Volume Control — 9 features — fully insulated bushing and shaft — accurate switch operation — stable and solid assembly — easy assembly — smooth action — simple mounting — easy, noiseless operation.



Stackpole Fixed Carbon Resistors — four sizes — 3-watt, 1-watt, ½-watt and ⅓-watt. New Booklet — gives complete technical data on Controls, Suppressors and Resistors, circuit diagrams, etc. Write for your copy.


Here's a smart performer, the new Automatic Tom Thumb, Jr., an AC-DC, 25-60 cycle set, using 5 new-type tubes.

People like them MOULDED

Planning a new midget? Tired of the overworked shapes and styles necessary with older cabinet materials? Then mold it of Durez, the newer, smoother molding compound. Scores of new designs are possible—designs that give your set identity and sales appeal. plus production advantages.

Molded Durez cabinets are richer, glossier, smoother, free from waviness. They come from the mold completely finished, uniform, ready for assembly. They're heat and moisture proof, walls and corners are thinner, inserts automatically imbedded, and they're warp-proof, chip-proof, seamless. Smart contrasts, like black and chromium, brown and coppers, or metal or wood inlays, as well as smooth solid colors, are possible. And the more you make, the more economical they are.

We'll gladly arrange contacts with experienced designers and molders. For further details, samples, etc., write General Plastics, Inc., 1211 Walck Road, N. Tonawanda, N. Y.

DUREZ *for Smoothness*

ENAMELITZ

Reduce manufacturing costs on I.F. and R.F. coils through the use of Enamelitz—"Litz" wire without a fabric covering.

Three Fold Savings—

1. Cost of wire
2. More coils per pound of wire
3. Less space—Greater safety

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Other Acme Wire Co. Products

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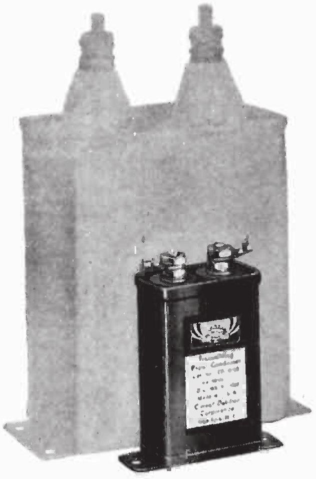
(Filter, By-pass, Power Factor Correction)

Aerial Wire
(Stranded and Solid—Bare or Enameled)

For over 25 Years, suppliers to the largest radio and electrical manufacturers.

THE ACME WIRE CO.
New Haven, Conn.



1/6th Size

with better

Operating Characteristics!

Here are two 1 mfd. units rated at 1000 volts D.C.—the usual standard paper unit and the new Cornell-Dubilier *special impregnation* unit.

The new unit measures only 1¾ x 1 x 2⅛ inches! But that is only the story of size. There's an even greater story to tell in superior characteristics of the new

C-D Specially Impregnated Units

Compactness and reliability made possible by special impregnating compound as well as careful selection of paper dielectric.

Conservative working voltage ratings, based on numerous life tests.

Superior operating characteristics and longer life.

Available in capacities of from 5 mfd. at 600 volts D.C., to 1 mfd. at 2000 volts. Width and depth dimensions fixed—1¾ x 1 inch; height varies from 2⅛ to 4¾ inches, depending on rating.

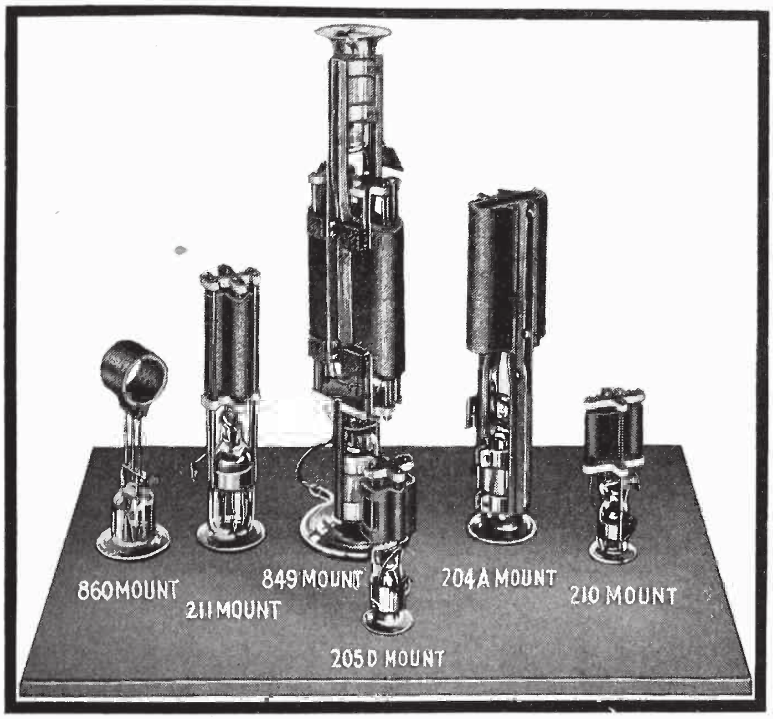
Write for further data on these new space-saving and money-saving capacitors, as well as our new 1933-34 catalog covering entire C-D line.

CORNELL-DUBILIER CORPORATION
4377 Bronx Boulevard
NEW YORK CITY

FACTS... about Sylvania

(Reg. U. S. Pat. Off.)

GRAPHITE ANODE TUBES



1 K.W. Type 851

● Transmitting tubes embodying anodes of PURE GRAPHITE were originated by Hygrade Sylvania Corporation. Sylvania engineers conceived and patented the process for successfully producing a plate of pure graphite.

There is no other manufacturer on the market with a complete line of these tubes.

The superiority of graphite anode tubes has been proven by many months of general service in transmitting fields.

Reasons that the engineer will readily understand are summarized below.

1 PURE GRAPHITE provides the physicist's ideal black body for maximum heat radiation. All hydrocarbons, binders and occluded gases removed by special process.

2 IMPROVED CONSTRUCTION. Rigid, one-piece anode machined from a solid block of carbon. Eliminates large masses of metal formerly employed for mechanical support and trussing.

3 NO WARPING. Ability of graphite to endure high temperatures enables it to retain machined dimensions. Results in permanence of characteristics throughout life. Insures maximum efficiency and high signal stability.

4 MINIMUM OF METAL. Freedom from occluded gases liberated by large masses of metal of older structure results in a "harder" tube.

5 COOL OPERATION OF ANODE. No transfer of excessive heat to grid. Plate does not reach incandescence. Heat is rapidly transferred to glass envelope which is designed to dissipate it efficiently.

6 COOLER GRID. Results in lower primary and secondary emission from grid. Eliminates gases usually given off by a hot grid.

7 GREATER OUTPUT. Increased heat dissipation permits greater loads or longer life at rated loads.

8 LONGER LIFE. Accelerated life tests show substantial increase in life over molybdenum-plate tubes.

9 HIGHER VACUUM MAINTAINED. Graphite when treated by the Sylvania process acts as a "getter", that is, absorbs gases normally released during tube life.

Write for technical data pertaining to Sylvania transmitting tubes available for immediate delivery.

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HYGRADE SYLVANIA CORPORATION

Hygrade Lamps **ELECTRONICS DEPARTMENT** *Sylvania Tubes*

CLIFTON, NEW JERSEY

FACTORIES

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WAREHOUSE FACILITIES IN

PORTLAND, ORE. CHICAGO, ILL. PHILADELPHIA, PA. LOS ANGELES, CAL. ATLANTA, GA. PITTSBURGH, PA. DENVER, COL.

Measure C, R, L, and Power Factor on This New Bridge

Note These Wide Ranges!

Capacitance: 8$\mu\mu$f to 100μf
Resistance. 0.01Ω to 1MΩ
Inductance: 5μh to 100h

THIS new bridge furnishes a ready means for measuring the capacitance, resistance, and inductance of circuit elements and of determining in a single operation, the power factor of the condenser and the "*Q*" of inductors. Except for the necessary head telephone used for the a-c measurements, the instrument is entirely self-contained.

The extremely wide range of values that this bridge can cover makes it of tremendous importance to the experimental laboratory where the need for measuring anything that may come up with good accuracy is of importance. For the first time an all-purpose bridge is commercially available at a reasonable price.

The Type 650-A Impedance Bridge is priced at $175.00.

•

Write for descriptive literature on these two new bridges. Ask for the April-May issues of the General Radio Experimenter and address the General Radio Company, 30 State Street, Cambridge, Massachusetts.

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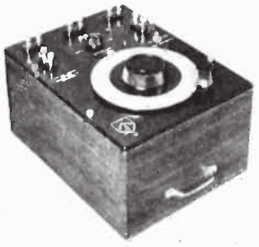

A new skeleton-type bridge is also available for laboratories where the wide range of the Type 650-A Impedance Bridge is unnecessary. The Type 625-A Bridge, with additional plug-in condensers and resistors, will be found useful for building up limit bridges and other special purpose instruments. *Price: $65.00 without accessories.*

GENERAL RADIO COMPANY

REMLER

15 WATT AMPLIFIER

With Condenser Microphone Power Supply

Dimensions: 21½ in. x 9½ in. x 10½ in. Weight 51 lbs.; Crated 63 lbs. List price complete with tubes. . **$200.**

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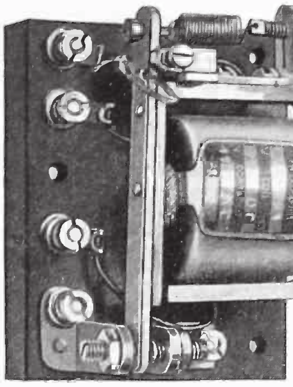

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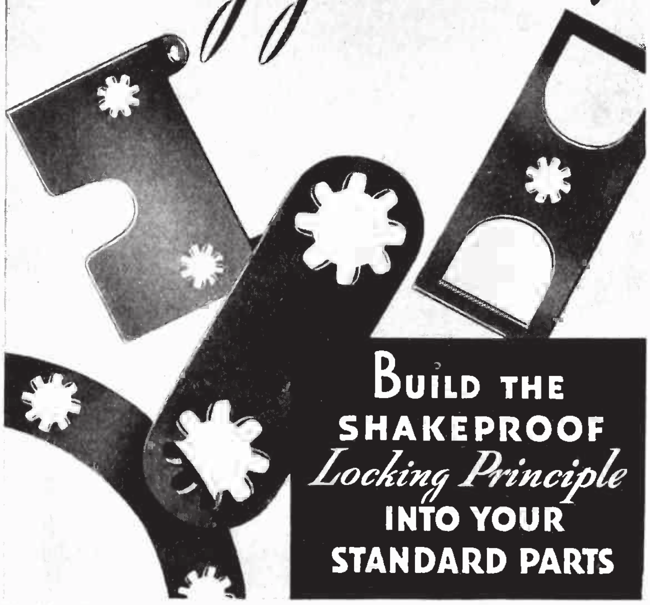

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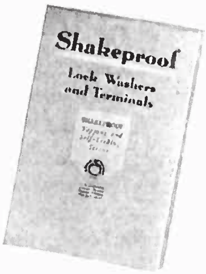

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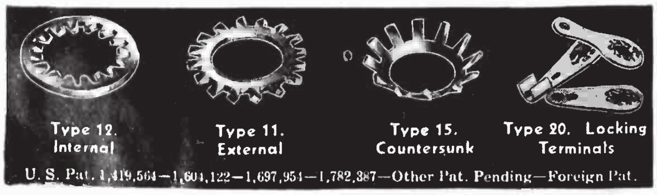

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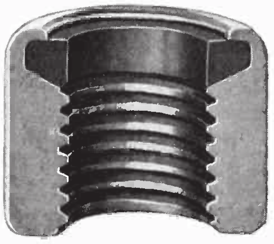

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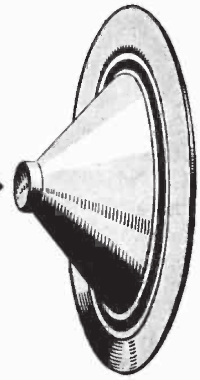

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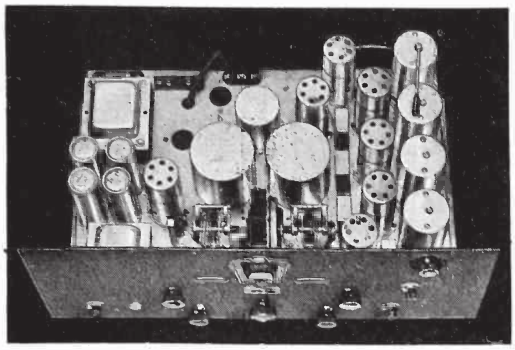

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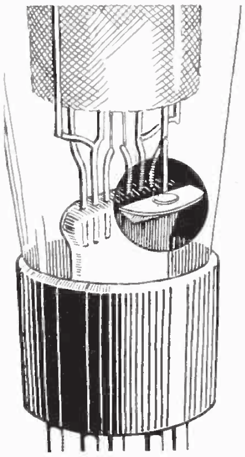

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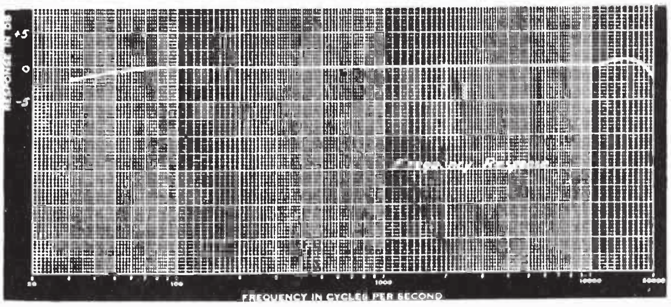

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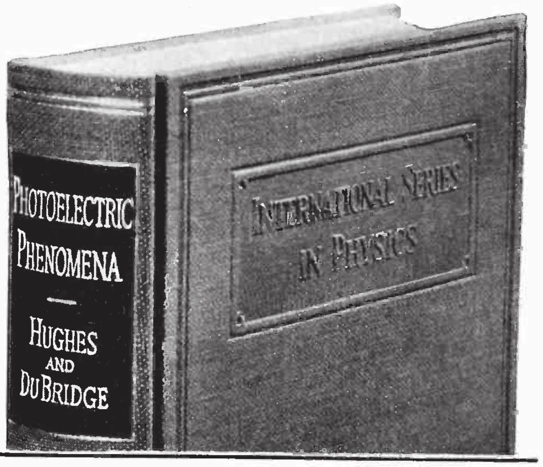

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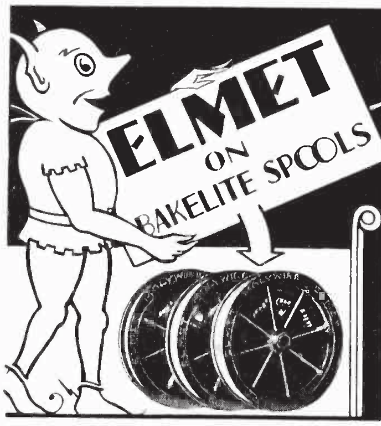

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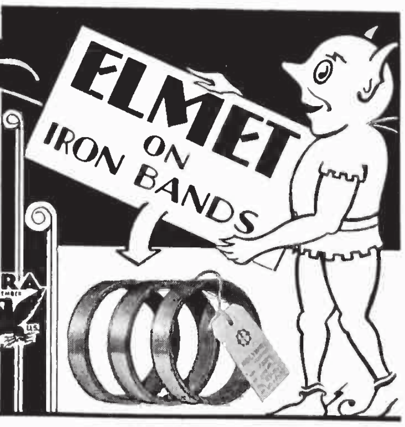

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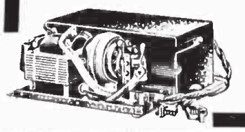

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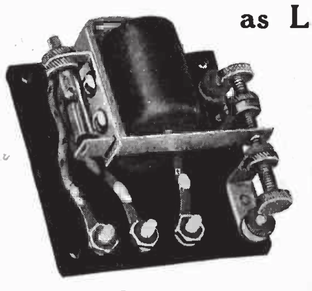

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Before me, a Notary Public in and for the State and county aforesaid, personally appeared B. R. Putnam, who, having been duly sworn according to law, deposes and says that he is the Secretary of the McGraw-Hill Publishing Company, Inc., publishers of Electronics, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, printed on the reverse of this form, to wit:

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Sworn to and subscribed before me this 29th day of September, 1933.

[SEAL] H. E. BEIRNE.
Notary Public, Nassau County. N. Y. Co. Clk's No. 1316, Reg. No. 4-B-950.
(My commission expires March 30, 1934)

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Think *"Searchlight"* First!

For Sale

NEW—RECONDITIONED—AND "AS IS"
ELECTRON TUBE EQUIPMENT

DESIGNERS AND MANUFACTURERS OF MACHINERY FOR THE PRODUCTION OF ELECTRON TUBES, NEON SIGN AND INCANDESCENT LAMP EQUIPMENT, TO MEET ANY REQUIREMENT.

EISLER ELECTRIC CORP.
USED EQUIPMENT ALSO AVAILABLE
Advise Us of Your Needs
756 So. 13th St., Newark, N. J.

HIGH GRADE NEW AND USED
ELECTRON TUBE EQUIPMENT

Write for Bulletin Showing Savings
From 20% to 80%

KAHLE ENGINEERING CORPORATION
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All types of High Grade New and Used Equipment for the manufacture of Electron Tubes.

Lowest prices on the market.

AMERICAN ELECTRICAL SALES CO.
65 East 8th St., New York, N. Y.

Year in and year out this trademark has stood for specialization and quality in resistor products.

Check your specifications and prices against these items

- Wire Wound Potentiometers from one ohm to 100,000 ohms.
- Composition Element Volume and Tone Controls in all values and standard tapers.
- Metal Covered Dropping Resistors—tapped or plain.
- Wire Wound Pilot Light Resistors.
- Sensitivity Controls of all values—size 1⅛ in. diameter by ⅛ in. thick.
- Tone Controls—size 1⅛ in. diameter by ¼ in. thick.
- Voltage Drop Resistors for reducing the input line from 260, 240, 220, 200, 175, 150 and 130 volts to 110 or 115 volts. These Resistors are equipped with American standard male or female connectors, in Continental European standard connectors, or United Kingdom standard connectors, as requested.
- Wire Wound Flexible Pigtail Resistors, from ½ watt to 5 watt.

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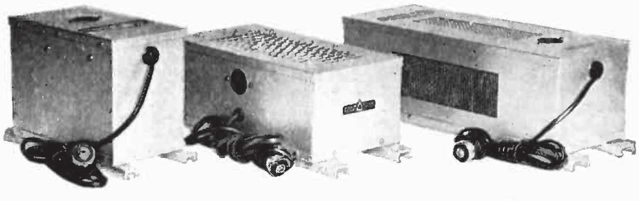
Clarostat Manufacturing Co., Inc.

285 North 6th Street, Brooklyn, N. Y.



60 Watt
120 Watt
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250 Watt

CONSTANT VOLTAGE

for All Socket Power Devices

LINE VOLTAGE 95 to 130, OUTPUT 115 ± 1%

A constant voltage is absolutely essential to the effective operation of many socket-power operated devices. Delta Voltage Regulators will maintain output voltage regulation within ± 1% with any load and line voltage within their operating range. Embodying the latest developments of our laboratory under the direction of F. S. Dellenbaugh, Jr., they are compact, efficient and contain no moving parts whatever. Users include: General Electric Co., Bell Laboratories, Federal Telegraph Co., Eastman Kodak Co., Western Union, and many others. Write us for specifications, stating your problem in detail.

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Entirely Automatic . . . Negligible Time-Constant

DELTA MANUFACTURING CO.
39 OSBORNE ST.,
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F. S. Dellenbaugh, Jr., Pres.
and Chief Engineer.

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Name ....

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A TIME-SAVER FOR THE ENGINEER ....

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RESISTANCE INDICATOR
BY THE MAKERS OF METALLIZED POWER AND PRECISION WIRE WOUND RESISTORS

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1. DUAL RESISTANCE INDICATOR
2. CALIBRATED RHEOSTAT OR VARIABLE RESISTOR
3. CALIBRATED POTENTIOMETER or VOLTAGE DIVIDER
4. Resistance measuring by SUBSTITUTION METHOD
5. TEMPORARY STANDARD RESISTOR

May also be used in place of resistor standards and decade boxes.

Like hundreds of radio servicemen, engineers and lab. workers are finding this new IRC Dual Resistance Indicator indispensable. Quickly gives the correct value for ANY resistor. Has many other uses besides. Two scales permit accurate readings from 100 to 100,000 ohms. Range may be extended by addition of fixed resistors. Improved ball-bearing (spring cushioned) contact is permanently attached. Built to last a life time.

$2.70 Net *(List price $4.50)*
(By mail include 15c. additional for postage)

INTERNATIONAL RESISTANCE CO.
2100 Arch St., Philadelphia, Pa.
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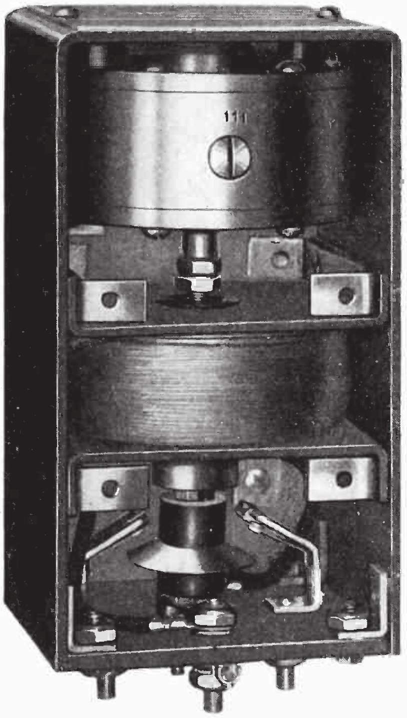
A NEW PRODUCT BY THE MAKERS OF FAMOUS

IRC RESISTORS



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Adjustable . . . Compact . . . Immediate Recycling . . . Temperature Compensated . . . Pressure Compensated . . . Time Interval Remains Constant . . . Snap Acting Contacts . . . Timing Independent of Voltage Fluctuations.

Types Available
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NA-12 Delayed Break After Coil is Energised
NA-21 Immediate Make When Coil is Energised
Delayed Break After Coil is De-Energised
NA-22 Immediate Break When Coil is Energised
Delayed Make After Coil is De-Energised

Infinite variations of timing effects possible by circuit combinations of above types.

Write for Bulletin with Technical Details, Application and Design Information

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Size 5¼ in. high x 2⅝ in. sq.

AMERICAN GAS ACCUMULATOR COMPANY
ELIZABETH • NEW JERSEY

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McGRAW-HILL PUBLISHING COMPANY, INC., 330 WEST 42d STREET, NEW YORK, N. Y.

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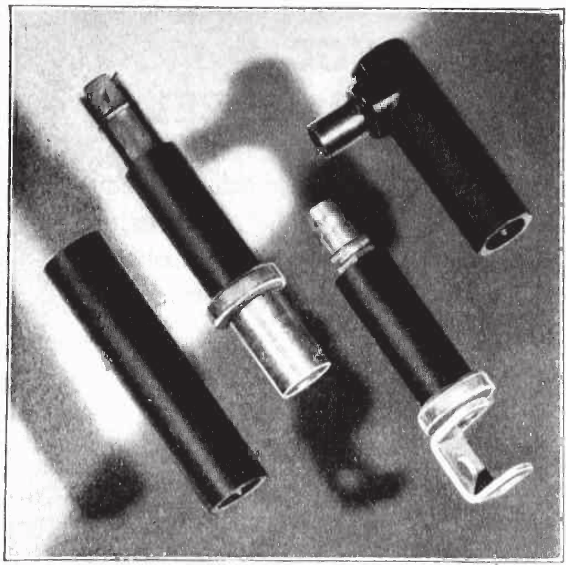
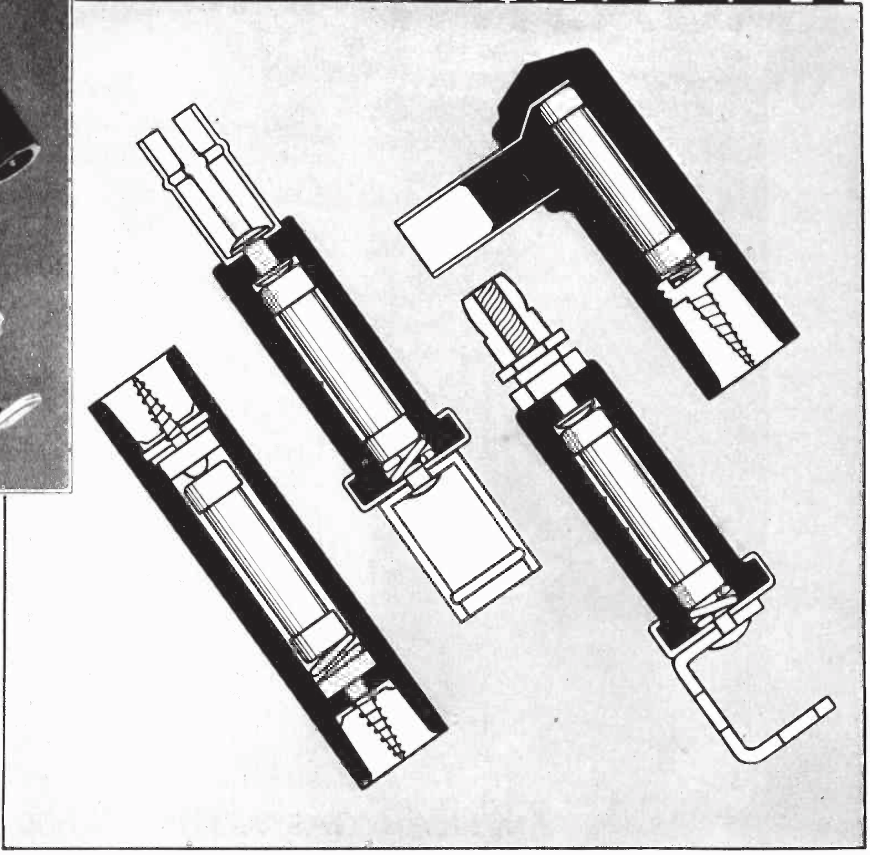
ALLEN-BRADLEY



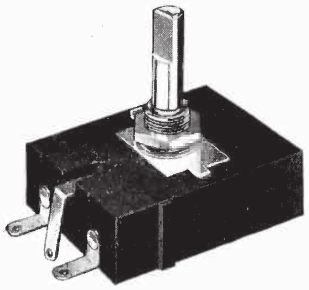
When you specify
Allen-Bradley
Spark Plug Resistors

you get the benefit of the pioneer experience of Allen-Bradley engineers who are foremost in the field of radio resistor design. Allen-Bradley spark plug resistors are covered by U. S. patents 1878014 - 1927185—other patents pending.



Bradleyunits

Bradleyunits are solid molded resistors unaffected by temperature, moisture or age. All units are color-coded.



Bradleyometers

The Bradleyometer is a potentiometer with approximately fifty solid resistance discs interleaved between metal discs.

The total number of discs can be arranged in accordance with any resistance-rotation curve.

LONG-LIVED—PERMANENT—RUGGED

—three essential qualities that are built into Allen-Bradley Suppressors

Allen-Bradley Suppressors are long-lived. They remain permanent in resistance values even after thousands of miles of abusive automotive service.

They do not "open circuit" in service and thereby cripple the engine.

They do not "drop" in resistance and therefore fail as suppressors.

They do not have a "high voltage characteristic" which sharply decreases the suppressor resistance during each spark discharge and thus defeats the purpose of the suppressor.

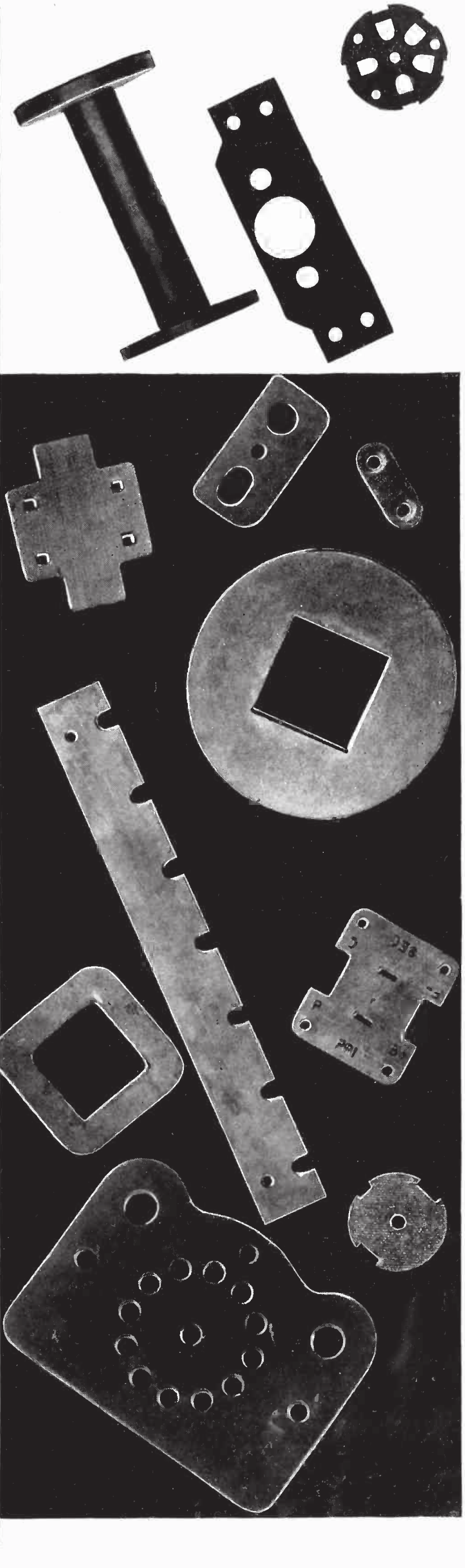
They do not fail from exposure to oil and water.

They do not break due to car or engine vibration. Careless mechanics are no terror to Allen-Bradley Suppressors, because the resistors are enclosed in rugged, non-arcing bakelite casings—not in brittle ceramic material.

The superiority of Allen-Bradley Suppressors can be easily demonstrated. Our engineers will gladly supply data and performance curves on resistors for your requirements. Write us today.

ALLEN-BRADLEY CO., MILWAUKEE, WIS.
General Offices—110 W. Greenfield Ave.

The Old Reliable



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FOR twenty years Formica has served important users of laminated insulating material, and during all of that time it has concentrated all of the resources of a steadily growing and steadily improving organization on the problems of producing a single kind and type of product.

This effort has provided one of the largest and most completely equipped plants in the industry. Formica can produce any grade or type of insulating material that you need. It can fabricate parts and deliver them to you promptly.

Formica offers a complete and competent insulating service.

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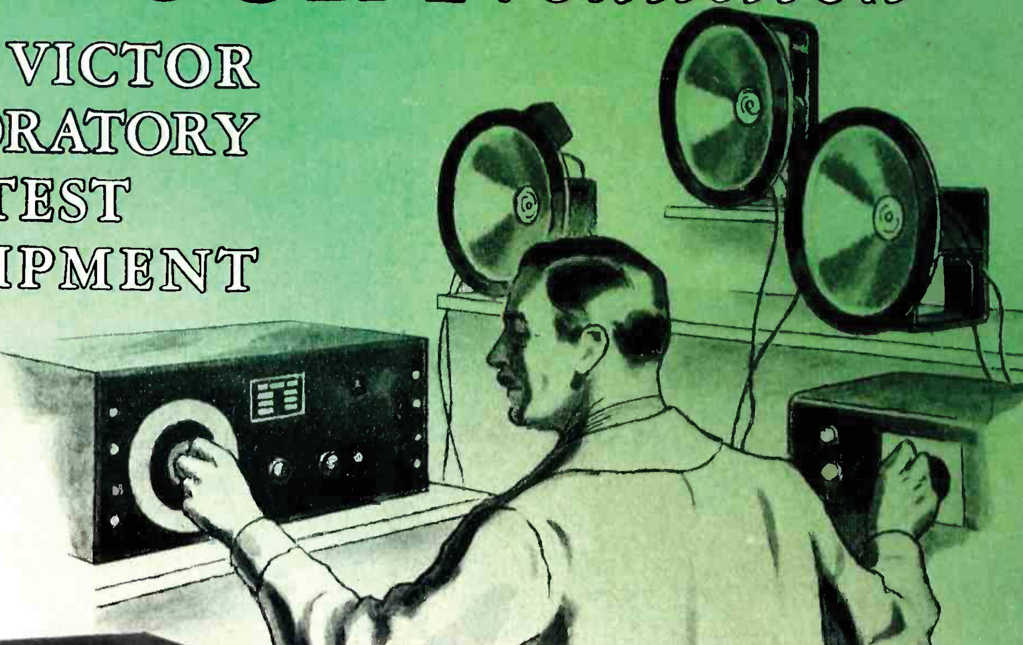
4638 Spring Grove Avenue, Cincinnati, Ohio.

FORMICA

For YOUR *Production*

RCA VICTOR LABORATORY TEST EQUIPMENT



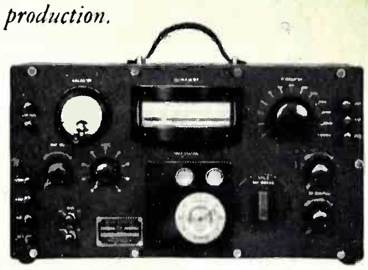
RCA Victor Beat
Frequency Oscillator
Type TMV-52-E

Important factors in maintaining speed and efficiency as well as perfection in producing your radio and electrical sound products . . . the RCA Victor Beat Frequency Oscillator and the RCA Victor Signal Generator... highly developed aids to fast and accurate check and adjustment on your product both in process and upon completion.

These highly perfected devices are now available for YOU—*for use in* YOUR *plant—to speed* YOUR *development and to keep perfect* YOUR *production.*

Are you losing valuable time and spending money on the development and production of these details?

Remove the guesswork from your test work—use genuine RCA Victor Laboratory Test Equipment We can save time and money for you—if you will give us the opportunity.



RCA Victor
Signal Generator
Type TMV-18-D

Faradon

The design and manufacture of capacitors is a highly specialized branch of the industry. Faradon capacitors have a world-wide reputation for efficiency, economy and reliability. Specify Faradon condensers in your new equipment. A size and type is available for your particular requirements. Send for the complete catalog covering this line.

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Take advantage of the experience and the efficiency offered by this great radio research and manufacturing institution

Industrial Products Section

RCA VICTOR CO., INC.

(A Radio Corporation of America Subsidiary)
CAMDEN, N. J.

electronics

radio, sound, communications and industrial applications of electron tubes · · · design, engineering, manufacture

NBC's new Radio City studios

◆

Broadcast system improvement

◆

Remote radio control by the transmitter

◆

IRE Fall Meeting report

◆

New cathode ray tube design

◆

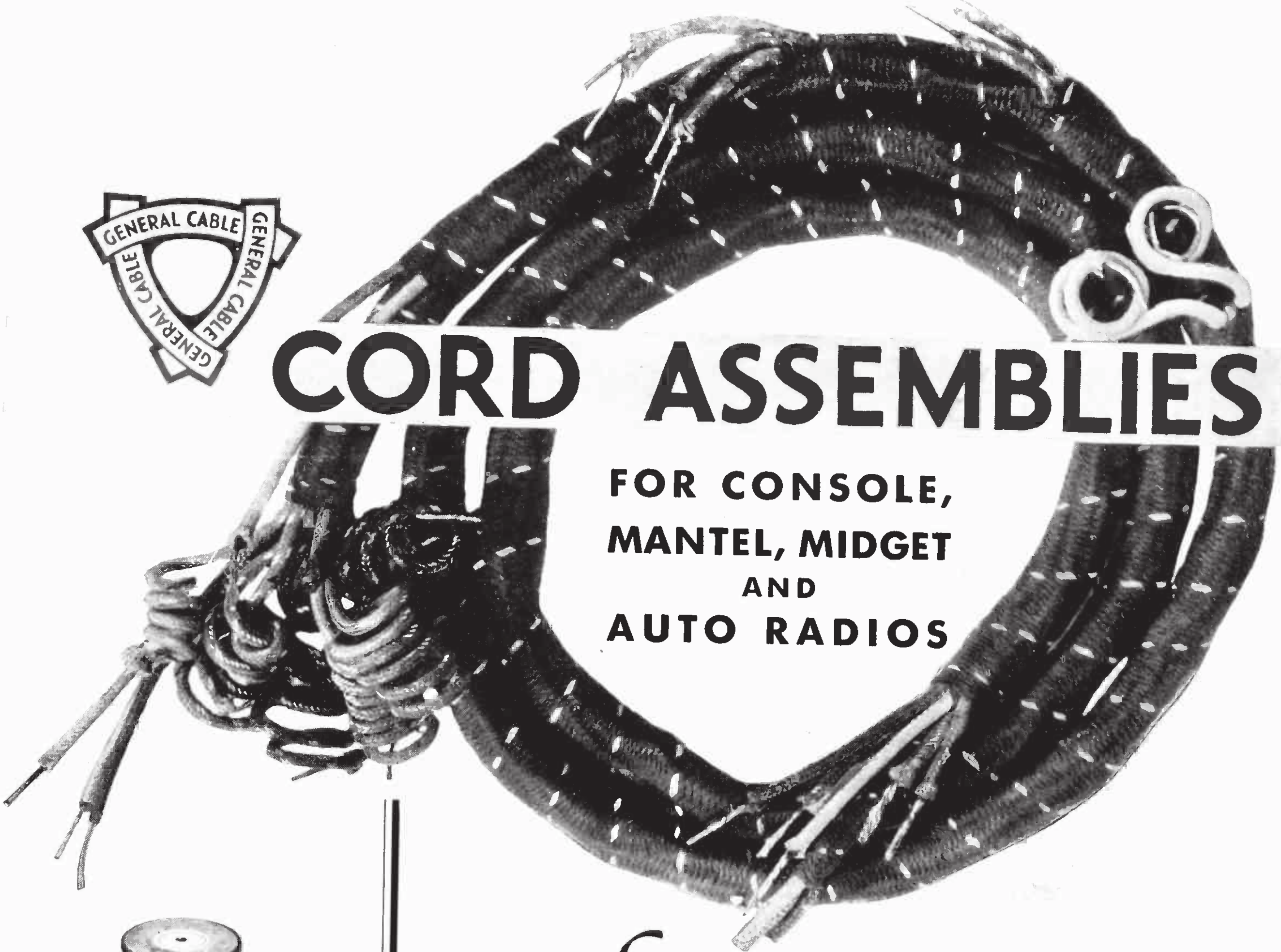
Anodes of graphite

Master control board with pre-setting arrangements. New NBC studios, Radio City

McGRAW-HILL PUBLISHING COMPANY, INC.

Price 35 Cents

DECEMBER, 1933



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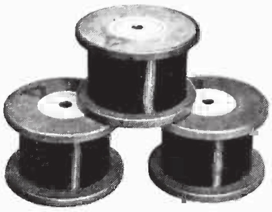
**FOR CONSOLE,
MANTEL, MIDGET
AND
AUTO RADIOS**



MAGNET WIRE

SQUARE FLAT OR ROUND

and COILS

HOOK UP WIRE

Push back wire, antenna loops and other radio specialties. Profit by General Cable standardized uniformity.

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...*Engineered* to the practical needs of service satisfaction...

Take our auto radio power cable and speaker connection assemblies for instance: especially vibration resistant, fully shielded where necessary, and with that dead soft flexibility that makes a friend of the man who does the car installation ...Here, as in all General Cable harness building, special inspection for soldering lug perfection aims to keep your assembly line moving like clockwork.

Backed by the Service of

NRA MEMBER U.S. WE DO OUR PART

GENERAL CABLE CORPORATION

420 LEXINGTON AVENUE, NEW YORK CITY • OFFICES IN PRINCIPAL CITIES

ELECTRONICS, December, 1933. Vol. 6. No. 12. Published monthly, price 35c. a copy. Subscription rates—United States, Mexico, and Central and South American countries, $3.00 a year. Canada, including duty, $3.50 a year. All other countries, $4.00 a year or 16 shillings. Entered as second class matter April 4, 1930, at Post Office at New York, N. Y., under the Act of March 3rd, 1879. Printed in U. S. A. Cable address "McGrawhill, New York." Member of A.B.P. Member of A.B.C. Copyright 1933 by McGraw-Hill Publishing Co., Inc., 330 West 42d Street, New York, N. Y.

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✓ CHECK THESE POINTS

. . . when buying Cathode-Ray Tubes

1. QUALITY

RCA Cathode-Ray Tubes are manufactured to laboratory standards of precision. Comprehensive tests have demonstrated their excellent life performance.

2. AVAILABILITY FOR RENEWAL

The RCA Monogram is your assurance that these designs are standardized and will be available when required for renewal purposes.

●

RCA Radiotron Co., Inc., has recently announced four cathode-ray tubes of the hot-cathode, high-vacuum type, and two supplementary tubes for use with the cathode-ray tubes. These designs are the result of an intensive research and development program over a number of years and are carefully chosen to meet the diversified needs of oscillograph application.

TYPES AVAILABLE

RCA-903 — 9 inch screen. Electro-magnetic deflection.
LIST PRICE . . . $120.00

RCA-904 — 5 inch screen. Electro-static-magnetic deflection.
LIST PRICE $50.00

RCA-905 — 5 inch screen. Electro-static deflection.
LIST PRICE $40.00

RCA-906 — 3 inch screen. Electro-static deflection.
LIST PRICE $18.00

RCA-878 — A high-voltage, high-vacuum rectifier.
LIST PRICE $11.00

RCA-885 — A gaseous-type triode, suitable for sweep-circuit control.
LIST PRICE $2.00

TECHNICAL INFORMATION AVAILABLE

Commercial Engineering Section,
RCA Radiotron Co., Inc., Harrison, N. J.
Please send me the newly prepared technical information on RCA cathode-ray tubes and supplementary types.

Name ....
Street ....
City .... *State* ....

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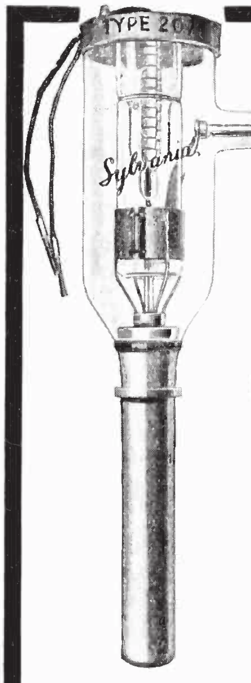
RCA RADIOTRON CO., INC.

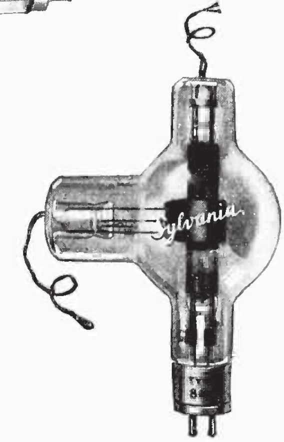
HARRISON · · · · NEW JERSEY

A Radio Corporation of America Subsidiary

Immediate Deliveries



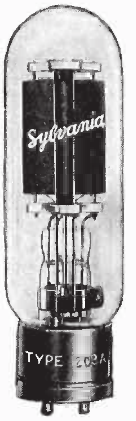
THE 207



THE 860

THE 872A

THE 866



THE 203A

THE 865

ALL TYPES ILLUSTRATED IN STOCK AT THESE WAREHOUSE POINTS OR FACTORY:

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CHICAGO, ILL.
SALEM, MASS.
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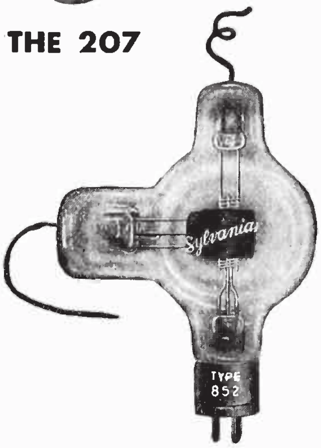
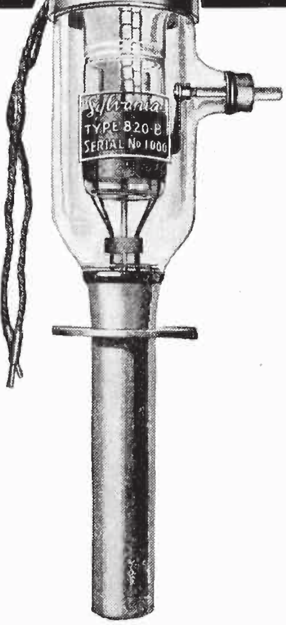
PHILADELPHIA, PA.
PITTSBURGH, PA.
LOS ANGELES, CAL.



THE 852

THE 849

THE 204A



THE 820B

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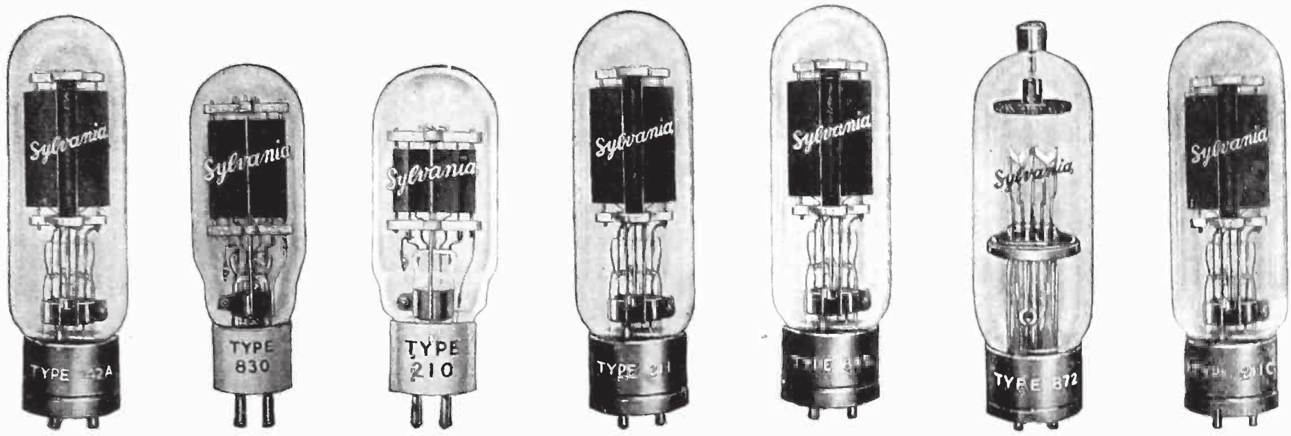
MODERN TRANSMITTING TUBES



THE 242A **THE 830** **THE 210** **THE 211** **THE 845** **THE 872** **THE 211C**

ALL SYLVANIA AIR-COOLED TYPES USE GRAPHITE ANODES

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Hygrade Lamps *Sylvania Tubes*

ELECTRONICS DEPARTMENT

CLIFTON, NEW JERSEY

FACTORIES:

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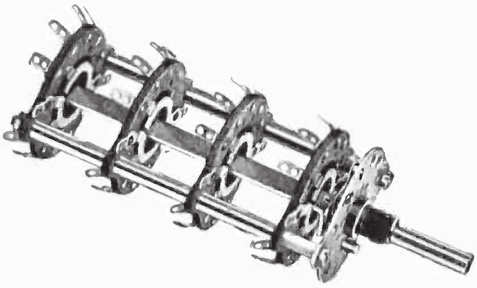
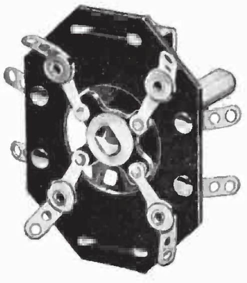
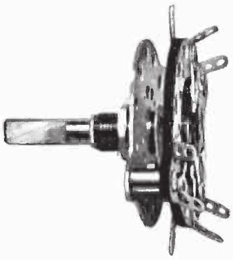
YAXLEY offers the largest and most complete line of switches available to the radio industry...





SHORT WAVE SWITCHES

used by practically all manufacturers of popular 1933 receivers. Yaxley Short Wave Switches excel in flexibility in design and are particularly adaptable for *all* types of short wave work. They afford practically all circuit combinations and various arrangements of circuits.

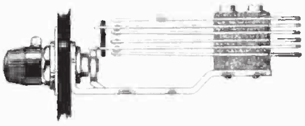


SELECTOR SWITCHES

noted throughout the field for outstanding mechanical features.

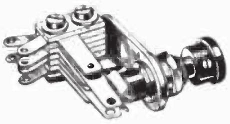
TAP SWITCHES

for test equipment and laboratory purposes.



JACK SWITCHES

in practically all combinations.



PUSH BUTTON SWITCHES

of locking and non-locking types.

MULTIPLE POINT RECORDING SWITCHES

for phonograph-radio and recording receivers.

YAXLEY will welcome the opportunity to co-operate in the development of the proper and most efficient switches for your new models

Executives of one large manufacturing organization recently said: "We intend to put all our switch problems up to Yaxley." We want you to feel the same way. Our engineers will gladly co-operate with your engineers at any time.

NRA

YAXLEY

YAXLEY MANUFACTURING CO.
INCORPORATED

MALLORY

Division of P. R. Mallory & Co., Inc., **INDIANAPOLIS, INDIANA**

electronics

O. H. CALDWELL
Editor
KEITH HENNEY
Associate Editor

McGRAW-HILL PUBLISHING COMPANY, INC.

New York, December, 1933

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musical instruments
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television
metering
analysis
aviation
metallurgy
beacons
compasses
automatic processing
crime detection
geophysics

The balance-sheet of TELEVISION

IS television ready for the public?

Put this question to the men who are in the center of television research and development today, and a wide variety of answers will be forthcoming.

Some say "Yes. Television is all ready for public exploitation." Others insist "No. Television is still in the laboratory stage. Some entirely new process will have to be discovered before television can become an entertainment art comparable even to home movies." So there you are. The experts disagree.

Let us put down the factors pro and con, in the television picture as 1934 approaches.

Discouraging

Lack of detail in pictures
High cost of television set
Expense of tube replacements
Small range of single transmitter
Difficulty in "chaining" stations
Tremendous studio expense
Problem of who will pay for transmission

Encouraging

New cathode-ray pick-up devices
Improved cathode-ray televisor tubes
Increased intensity of illumination
Large projected pictures
Wide band transmissible by new conductors (2,000,000 cycles)
Possibility of outdoor news scenes
Developments in ultra-short-wave apparatus

HERE is much evidence of progress—yet also this testimony falls short of proving that commercial television may be expected in 1934 or 1935.

But the men who know are talking television more optimistically than ever before, and where there is such an increasing volume of smoke, there must be fire. Television may have some surprises for the conservatives before another twelve months roll around, so the television optimists insist.

NBC'S NEW STUDIOS

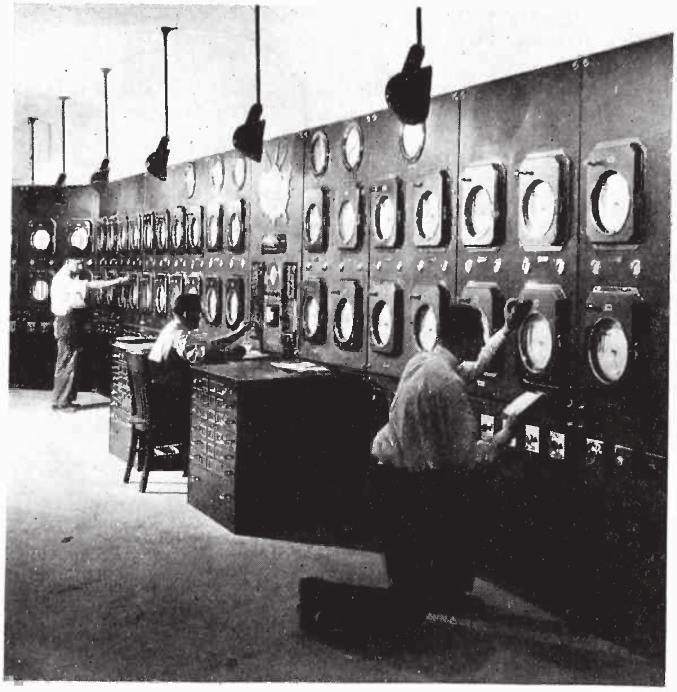
Master control board; pre-set switching; 16,000-cycle circuits; dial monitoring

THE world's largest and finest radio-broadcasting studios are now in operation at Radio City, New York. Built by the National Broadcasting Company at an outlay of five million dollars, they incorporate many novel features of design and arrangement, in addition to their sheer size and completeness.

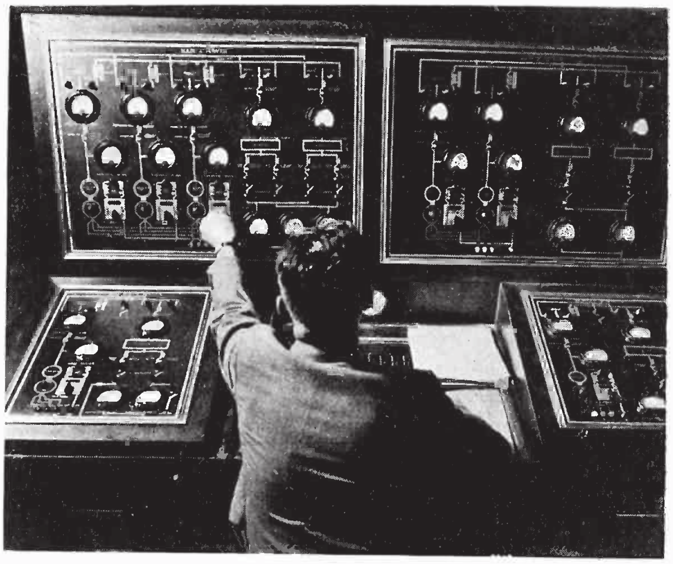
Thirty-five studios of various sizes are provided, of which sixteen went into operation in November; eleven others are yet to be electrically equipped, and eight more will be installed in the unfinished floors. The mammoth three-story auditorium studio measures 78 by 132 feet and seats 1600 people. Another large theater studio is equipped with opera chairs, stage, and a sound- insulating glass curtain which slides in from the wings, in sections. A unique four-unit "clover-leaf" studio group, provides four studios served by a central operating room glassed in on all sides. Suitable for eventual television productions, this studio group has immediate application for carrying out the English practice of setting up a broadcast with the vocalist, orchestra, speakers, etc., in different sound-proof quarters, and combining them at different levels to produce the desired ensemble effect. Several of the studios also have controllable acoustics in the form of motor-operated panels and curtains, which can be manipulated from the corresponding studio control-rooms to produce any degree of sound reflection in any part of the room.

In the general layout of the new Radio City studios, attention was given to the four different kinds of personnel traffic which move through a large broadcast studio group:

1. The artists, speakers, performers, musicians.
2. The operating staff, announcers, production men, engineers, servicemen, etc.
3. Audiences invited to witness broadcasts.
4. Sightseers or "tourists" (who now pay 40 cents apiece to be conducted through the studios).



The recording thermostats for the sixty-four units of the air-conditioning system which handles 20 million cubic feet of air per hour



The power control desk for the new studios. Small lamps show which circuits and machines are energized

Accordingly the Radio City studios are so arranged that entirely separate channels and corridors are provided for these classes of traffic, so that they do not come into contact with each other. Thus there are reception rooms and lobbies for the performers and speakers, opening into the studios; while the operating staff reach the studios through corridors that interconnect with the offices. Meanwhile the public can be admitted to the large auditorium studios, and "tourists" can be conveyed through the building without directly contacting any of the working quarters, except through observation windows.

Sandwiched in between the several studio floors is the operating floor with its master control board, where are centered the operations of all interconnections between studios and lines. With two operating positions and a monitoring position, this great master control board provides for the pre-setting of connections in any combination in advance. Then at the moment of program changeover, pressure on a single button causes all the former connections to drop out and the new ones to be automatically established. This switchover can be performed from the announcer's position or from the master control board itself. A number of advance circuit arrangements can be pre-set if desired, and then

IN RADIO CITY

Sound-proofing; movable acoustic panels; air conditioning; multiple traffic lanes

operated in succession, although ordinarily only the circuits for the following program are set up during any ordinary operating period. The elaborate flexibility of this master control scheme makes it possible to have separate studio programs feeding into the two local stations WEAF and WJZ, while other studios are feeding the Red and Blue networks, and still others are transmitting auditions to out-of-town telephone circuits.

Coupled with this circuit control is the dial-controlled monitoring system operating loudspeakers in all operation centers and offices, some 120 in number. By dialing, in the same way that an automatic telephone is used, any of these offices or control rooms may listen in on any studio or audition room, on either chain, on either local NBC station direct, or on any of the principal metropolitan stations through special broadcast receivers taking their input from the air.

The necessity for the large number of studios to be installed at Radio City (35) is explained when it is realized that for every hour on the air, about seven hours of studio preparation and rehearsal are required. With two networks to keep in continuous operation, and with two local stations which sometimes have separate non-network programs, a multiplicity of studio facilities is needed. Furthermore, a variety of studio sizes must be available for the various rehearsals.

The studios contain outlets for 250 microphone connections, giving wide flexibility of microphone placement. Three-quarters of the "mikes" used are of the new velocity type, the remainder being condenser microphones. All of the circuit equipment will transmit a full band from 30 cycles to 16,000 cycles. The loudspeakers in the control-rooms and offices reproduce up to 10,000 cycles, which may be later extended by special high-frequency units.

Some 1250 miles of wire is used in the studios alone, cut into 10,000,000 pieces, involving 20.000,000 soldered connections. Six hundred union electricians were required to complete the installation.

Elaborate precautions against the leakage of outside sound into studios, have been taken by soundproofing and acoustically treating the corridors and lobbies, the ducts for the air-conditioning system, and the vestibules between the pairs of soundproof doors entering each studio. The studios are built like "boxes within boxes," separate rooms within separate rooms, raised from the building floors by steel springs covered with felt. The studio walls make use of several inches of rockwool covered by perforated transite, which in turn is covered with decorative fabrics applied by sound-insulating glue. There are 150,000 square feet of this sound-insulating board, backed by 500,000 pounds of rockwool.

The acoustic and structural separation between studios and control rooms made it necessary to construct special triple plate glass observation windows. As many of the panes are too large to be removed for cleaning, the two intervening air-spaces between the three panes of plate-glass are hermetically sealed. To compensate for changes in barometric pressure, which would impose many tons of strain on the glass panes, a special system of valve inlets, with dustproof filters has been provided, which admit air to the internal spaces, but keep it free

A massed orchestra of 400 musicians playing in the huge auditorium studio which measures 78 by 132 feet, and seats 1,600. Three other studios each measure 50 by 80 ft. or larger

of dirt. The observation windows alone employed 8,500 sq.ft. of plate glass.

The air-conditioning plant is capable of handling 20 million cubic feet of air per hour, which completely changes the air in every studio once each eight minutes. The air-conditioning plant is built in sixty-four units, each self-controlled by a registering thermostat. All feed and exhaust air-ducts are lined and coated with rock-wool to absorb transient sounds. Stream-lined grills have been employed to reduce wind sounds to a minimum, and the air-ducts are connected to the inner studio walls by canvas hose to prevent transmission of vibrations to or from studios. The cooling tanks for the air-conditioning system are mounted on the roof of the studio section of the building.

Provision for future television broadcasting in the NBC studios, is seen in the use of special direct-current circuits for all studio lighting, although all the rest of the Radio City group is served with the usual 60-cycle alternating current. Such 60-cycle flicker would cause interference with television scanning, so direct current was used throughout the studios.

The special flush type of lighting unit used in the new studios and lobbies deserves particular notice. Prismatic glass panels control the spread of the light, to deliver uniform intensity on the working plane, and the effect is that of cheerful sunshine streaming from the ceilings, but without glare from exposed surfaces. The illumination is entirely utilitarian, no decorative color effects being attempted in the new installation.

The eight special elevators in the bank serving the NBC studios, are equipped with photo-cell safety door control, as are the fifty other elevators in the RCA building. Two beams of light projected across the threshold of each car, shine on photo-cells. If any passenger's body or clothing projects across the car doorway, intercepting either of these beams, the door will not close and the car will not start. Even if a passenger attempts to jump between the closing doors, his interception of the light-beam will effect instant reversal of the door mechanism, opening the doors wide, automatically, and preventing any possible accident.

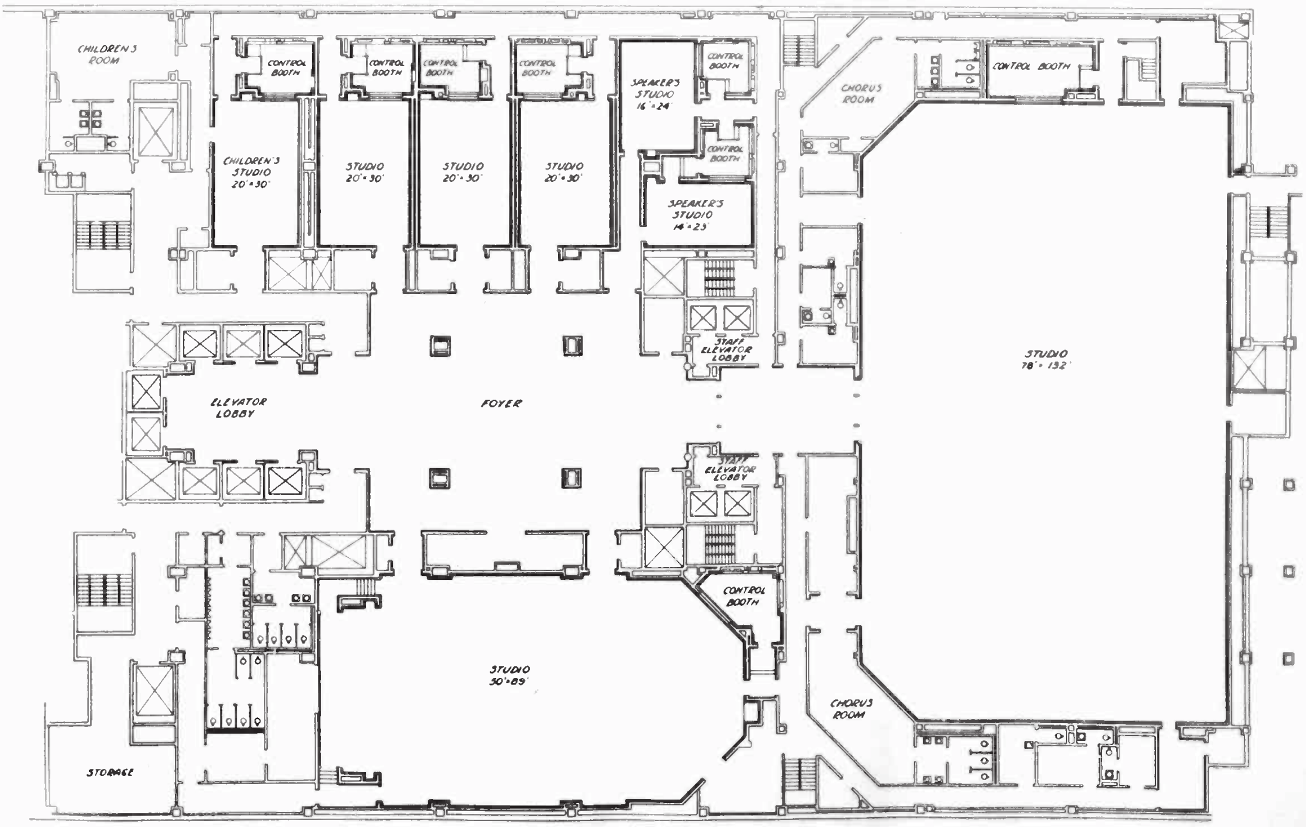
Every care has been taken to insure the continued operation of the studio equipment in the face of accident. For example, the interconnecting-rack room on the operating floor to which are brought all circuits from the control board, studios, relay panels, etc., is built as an air-tight enclosure, provided with automatic carbon-dioxide guns, which in case of fire fill the room with inert gas, smothering out any fire.

In the same way, storage-battery protection is afforded against interruption of power supply. The battery capacity will take care of all operating needs for forty-eight hours, supplying both the 400-volt B battery and the 14-volt A bus.

The electrical and audio equipment for the new Radio City studios is estimated to have cost about two million dollars. For the sound-insulation and acoustic treatment, air conditioning, etc., another two millions were expended. Thus with a million dollars for the eleven-story steel structure housing the studios, the total investment comes to about five millions.

The RCA Victor Company, Camden, N. J., built the electrical, radio and audio equipment. Power apparatus was furnished by the General Electric and Westinghouse companies. The Johns-Manville Company supplied the acoustic material, and Carrier Engineering Company, the air-conditioning apparatus.

The design and installation of the studios was carried out under the supervision of O. B. Hanson, engineer in charge of operation for the National Broadcasting Company.



Typical studio floor layout, showing the central lobbies for performers and members of audiences; also the outer corridors by which the NBC operating staff can reach all studios and control rooms

Controlling receivers

from the broadcast transmitter

THE desirability of some means of controlling the operation of home receiving sets from the broadcast transmitter, so as to ring a bell, light lamps, turn on the set itself, or perform some other operation, was pointed out editorially in *Electronics* for August, page 227. At that time we said:

> **Why not a signal bell to call the radio listener?**
>
> **Each day striking news events are inserted into the broadcast programs, changing the routine schedules. Yet unless the listener has his own radio set continuously tuned in, he misses these most thrilling features of the radio day.**
>
> **Every telephone is provided with a bell to attract the user's attention. Without a bell, a telephone would be only 50 per cent as useful.**
>
> **Yet the average radio receiver is like a telephone without a bell.**
>
> **The listener misses some of the best things on the air, because he has no way of being notified. If there were some way of calling him to his radio set by means of a bell or a signal light, he would be able to enjoy special features. And so the public's appreciation of broadcasting generally would go up.**
>
> **A low-frequency control tone on the station's carrier-wave, inaudible to the ear, but capable of operating a signal relay, might be one way to do the job.**
>
> **Such a service would help popularize radio and bring the public to realize more fully the wonderful things the broadcasters provide.**

Other services besides ringing a bell or lighting a lamp to summon the broadcast listener, might be performed in the same way. For example, the radio set could turn itself on to full volume when the impulse came from the broadcast transmitter.

Or by a series of tuned relays, one of a row of colored lamps might be lighted, indicating visually what kind of program was at the moment playing in the silent set—say green for dance music, purple for symphonies, yellow for children's stories, and red for political speeches!

In fact, the listener might arrange to push a button under any one of these or other headings, and then at the first program of the kind he ordered, the set would turn itself on.

Learning that engineers of the Sparks-Withington Company, Jackson, Mich., have been carrying on some experiments of this kind, in connection with the Point O' Purchase Broadcasting System, Inc., Union Guardian Building, Detroit, Mich., Captain William Sparks, president of the Sparks-Withington Company, was asked for a statement and has supplied the following report of the tests being carried on by his company.

"A radio receiver which automatically picks out the desired type of program or remains quiet until such a program comes on the air, whether it is news, market reports, weather, comedy or a favorite dance orchestra, has been discussed as being a possibility of the future.

"The practicality of such a system has recently been demonstrated in a series of tests in conjunction with transmitters CKLW at Windsor, Ontario, and WABC at New York City. These tests showed that it was perfectly possible to start and stop a receiver from the transmitter without interfering with the program or producing any audible disturbance in other receivers.

"Inaudible low frequencies modulating the carrier of the transmitter at a minus 17 to minus 20 db. level were used to actuate relays in the receiver. Of course, it was necessary that that part of the receiver up to the relays be in operation at all times, only the power tubes and loudspeaker being placed in and out of operation due to the action of the relays.

"Several engineering problems had to be solved and a great many tests were run before correct operation of all the components parts could be realized. Modulating frequencies between 25 and 40 cycles were used at the transmitter. It was found that the studio-to-transmitter lines and amplifiers of most broadcasting stations are not equipped to handle these frequencies satisfactorily, and it was, therefore, necessary to place the low frequency generator directly at the transmitter.

"It was found that a separation of 1½ cycles between actuating frequencies was all that was required from a selectivity standpoint to operate the desired relay.

"It was at first believed that static or low frequencies of music, particularly the pipe organ, might actuate the relays since such low-level modulation at these frequencies would cause the relays to operate.

"Alloy steel reeds tuned to the different frequencies gave the required selectivity, and were equipped with contacts so that during the course of vibration a secondary circuit was closed and large amounts of power could be controlled. Selectivity of the reeds automatically produced a time delay action which prevented static and low musical notes from causing them to vibrate with sufficient intensity to close their contacts. An overloading device was provided which prevented more than a given amount of energy to be impressed upon the reeds, thereby preventing them from being shock excited sufficiently to cause operation.

"The frequency generator at the transmitter consisted primarily of toothed steel discs driven by a synchronous motor between magnetic pickups in such a manner that the teeth varied the magnetic circuit and induced the tooth frequency into the windings. Suitable electrical filters were used to keep the output free from audible harmonics of the generated frequency. Variations in the 60-cycle supply voltage frequency were, of course, reflected directly as variations in the output frequencies of the generator. However, these were found to be of an entirely tolerable magnitude.

"The receiver relay operation was smooth and completely satisfactory on signal levels between 60 microvolts and 750,000 microvolts at the receiver antenna without change or adjustment of the receiver or relays for the varying signal strengths.

"Tests over WABC were conducted during the middle of the day and during commercial programs. However, it is doubtful if anyone in the vast audience of this large transmitter other than those at the special receiver many miles away were aware that anything out of the ordinary was going on. During 'dead air' the best radio receiver would not produce an audible sound from such low level, low frequency modulation."

RECENT ADVANCES

IRE, RMA, NAB discuss improvement in broadcast transmission and reception

NOVEMBER, just closed, proved to be a busy and important month for the technical portion of the radio industry. At a well attended meeting of the New York Section of the IRE on Nov. 8, Stuart Ballantine of Boonton Research Corporation, read a paper on "High Quality Broadcast Transmission and Reception," presenting the results of a systematic two-year experimental study of the entire radio broadcast system, from microphone to loudspeaker sound field. The weaknesses of the current system were pointed out by Mr. Ballantine and definite remedies suggested in each case. The various points were clearly illustrated by a rather elaborate audible demonstration, using program material broadcast by the Columbia Broadcasting System especially for the meeting.

Almost immediately afterward the annual Fall Meeting of the Rochester Section of the IRE took place, and the subject of how to improve the entire broadcast system from microphone to loudspeaker was discussed again and, it is hoped, with some ultimate effect.

At the New York IRE meeting Mr. Ballantine, in considering the transmitting end of the system, showed wave response curves of thirty microphones of six different commercial types and presented figures showing the proportions of the various types used in stations operated by the two chains. He stated that the microphone was responsible for considerable frequency distortion and one of the first steps in the improvement of the transmitting system should consist in the replacement of the older types, such as the carbon and condenser. Other defects requiring improvement are non-linearity of the modulation characteristic, more careful monitoring to prevent over-modulation, elimination of noise, studio technique and microphone placement. The present inadequate monitoring loudspeakers used in the studios should be replaced by high-fidelity types. Mr. Ballantine also described a new automatic monitor for the prevention of over-modulation.

WHAT IS WRONG WITH BROADCASTING?

Lack of power to over-ride noise

Hum on transmitters; over-modulation

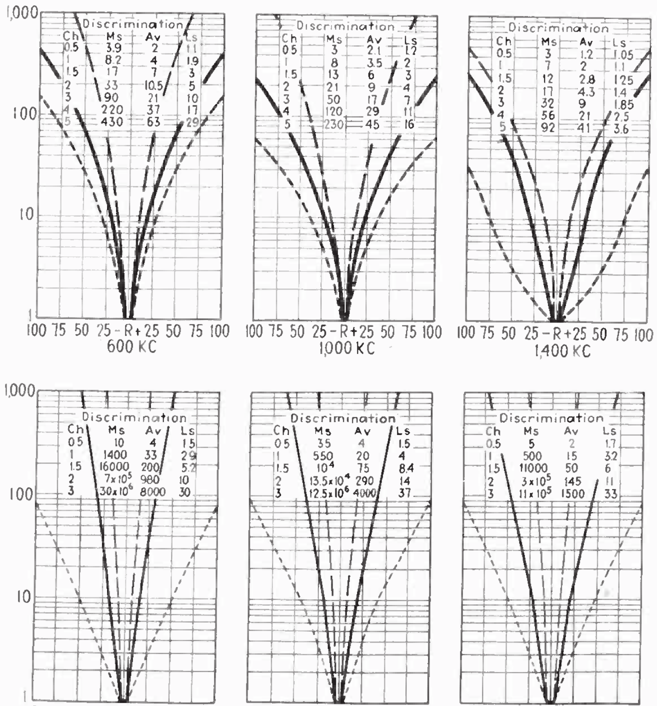
Bad microphones, or poor technique

Narrow frequency spacing between stations

Skimped response of average receiver

Amplifier, detector, speaker distortion

SELECTIVITY OF MODERN RECEIVERS



At the top are curves on TRF, supers at bottom. Maximum, average and least selectivity is shown as well as the discrimination for signals in various channels

On the receiving side the importance of overall measurements of receivers from antenna to sound field was emphasized. The special problems associated with high-fidelity reception were discussed. Practical solutions of these problems have been incorporated in two high-fidelity receivers which have been developed in the Boonton laboratories. Among the special appliances are: anti-"monkey-chatter" filters, microphone compensators, automatic audio range control, compensator for the effect of placing the receiver in different positions in an average living room. Mr. Ballantine also emphasized the importance of regarding the room as part of the loudspeaker and showed some interesting sound-pressure records, taken with an automatic recorder, which brought out the effects of the room and of placing the receiver in rooms of different sizes and shapes.

For the demonstration a high-quality line (equalized to approximately 15,000 cycles) was run from the CBS studios on Madison Avenue to the auditorium. A special musical program, exhibiting a wide range in pitch and volume, was picked up in the CBS studios by means of a new crystal microphone having a uniform response (within 3 db) up to 15,000 cycles.

IN THE RADIO ART

Fall Meeting papers reveal progress in television, radio receivers, components

IMPROVED PROSPECT FOR HIGH FIDELITY RECEPTION

Recent events point toward a better forging of weak links in the broadcast system. These are: open discussion of present defects; demand for higher power, better transmission; suggested assignment of 20-kc. channels outside present band; interest of Edison Association in receiver safety and performance standards.

By means of a high-fidelity receiver tuned to WABC it was possible to compare the direct high-quality pickup through the line with the same program after being broadcast and returned to the auditorium via radio. The speaker expressed his belief that a fully equalized system good to 7,000 cycles, as represented by the radio reception from WABC, would deliver sufficient fidelity of response to satisfy the most critical, although the difference between this quality and full range reproduction can be recognized on direct comparison. Mr. Ballantine also showed the effect of listening to a program that had been passed through 2,000 miles of wire line. To do this he had looped back to the meeting the complete New York-Chicago-Southern Circuit of the Columbia Broadcasting System. The slight loss in high frequencies and the time delay effects were distinctly audible.

A very convincing demonstration of the distortion caused by microphones was made by switching in the studio between the crystal microphone and a commercial type of microphone in current studio use. The 10 db. rise in response above 2,000 cycles with the ordinary microphone was clearly audible.

The crackling and distortion produced by over-modulation was next demonstrated by means of a low-powered transmitter installed on the stage and modulated by the material arriving over the wire line.

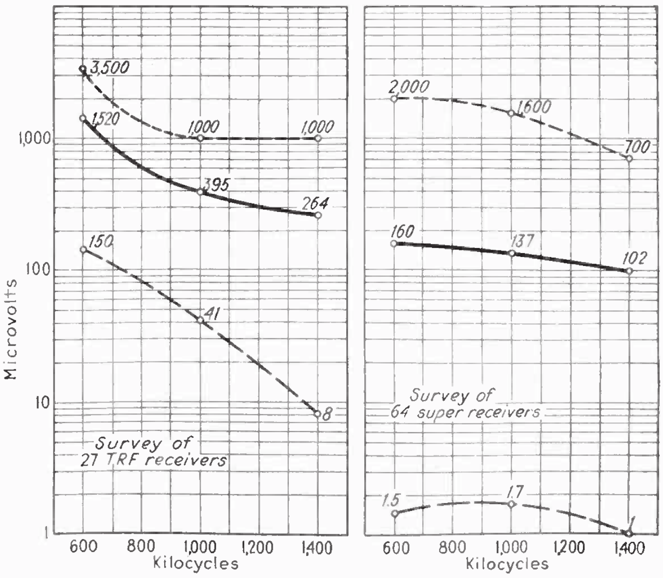
One of the most interesting new devices described by the speaker was an automatic volume range compressor and expander. By means of these devices a 70 db. volume range can be automatically compressed to 35 db. for wire line transmission and automatically expanded at the other end to the original 70 db. range. Application of this technique to wide volume range and quiet phonograph recording were mentioned.

The subject of improvements to the broadcast system came up again at Rochester as the result of a paper by Dr. A. N. Goldsmith on the conditions necessary for an increase in usable receiver fidelity. Here a number of fundamental weaknesses of the present system were pointed out and some others were added. To the fault of insufficient power to override static and noise, it was pointed out at Rochester that the level of performance attained by the better known broadcast stations was far above the average level and that the a-c hum on many carriers was making it difficult to sell receivers with good low frequency response. Measurements on stations indicated that in some cases the hum modulation amounted to several per cent of the carrier power. In general, this type of distortion is not difficult or expensive to remedy.

At a meeting of the receiver committee of the RMA Engineering Section at Rochester it was pointed out that Canada had applied to Berne for frequency assignments in the region between the present broadcast band and the ship-to-shore band (545 to 600 meters) and above the present broadcast band as well—that is the region between 1500 and 1600 kc. It was suggested that as an experiment on high fidelity broadcasting, the Federal Radio Commission and Canada give assignments for stations for these bands in 20-kc. intervals thus permitting a station to transmit 7500 cycles and leave a guard band between stations.

If such an experiment permitted radio receivers to operate successfully with a flat characteristic up to 7000

SUPER VERSUS TRF SENSITIVITY



A survey of 1932-1933 receivers made for NAB, IRE, and RMA gives these sensitivity data cycles, or higher, a precedent could be set for future extensions of the broadcast band or for a future allocation of the present channels.

At the Rochester meeting, Mr. Fred Williams, president of the RMA, pointed out to the engineers that he had long advocated the development of some visual or audible tests which a dealer could use to demonstrate clearly to a prospective customer the merits of a good receiver compared to a poor one. Engineers have felt that such tests were most difficult to make so long as it was not possible to make a receiver that was definitely superior to cheaper sets. So long as the set must cut off sharply at 5000 cycles to avoid beat note reception, and must actually cut off much before this limit to avoid crackle caused by bad modulation at the transmitter and the disturbances due to atmospherics, it is not possible to demonstrate the virtue of the high fidelity set.

If, however, a dealer could offer a radio with the fidelity and wide band demonstrated by Mr. Ballantine, and desired by all radio engineers, the argument in favor of better receivers would be won conclusively. In Mr. Williams' opinion, the advancement of the broadcast system advocated by the IRE and RMA engineers would enable a dealer to prove to his customer the skimped quality of a skimped price and sized receiver.

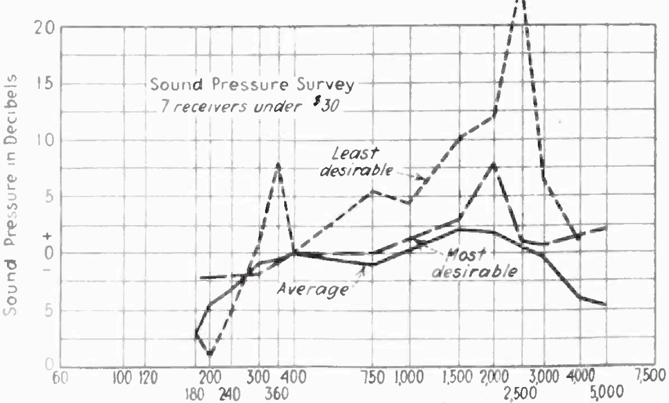
As a result of the interest shown in this subject, Dr. Goldsmith was invited to lay before the board of directors of the RMA a plan for an orderly and progressive improvement of the system. In this endeavor Dr. Goldsmith will have the aid and encouragement of the technical members of the entire industry.

Another favorable event leading to an ultimate betterment of radio receivers is the interest shown by the Association of Edison Illuminating Companies in setting standards of receiver safety and performance.

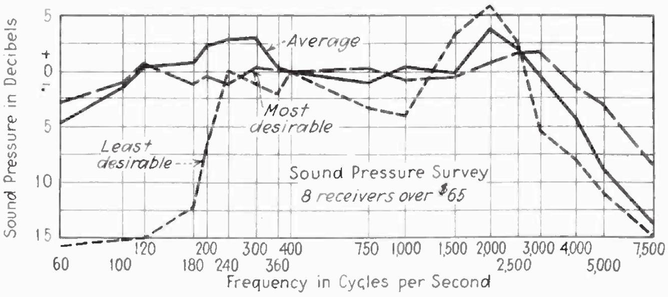
Now that the utilities are getting service calls on defective radio receivers, the Association feels it must set minimum standards for such apparatus so that its membership will be guided as to the merchandise it will offer for sale and which they will service. Electrical Testing Laboratories will set the standards, test the receivers and make lists of approved equipment.

Such standards set by an organization not interested in manufacturing radio receivers should aid in protecting the public from the shoddy and dangerous merchandise offered in quantities during the past several years.

Cooperation between this group and the RMA Standards Section might be utilized by the latter group to educate the utilities in necessity for the elimination of the man-made static which now makes impossible the sale of high fidelity receivers except to listeners very near powerful stations.



Narrow range plus non-uniform response marks the cheap, small receiver



Wide-range response of the more expensive receivers

The Rochester papers

Among other papers presented at the Fall Meeting was a résumé by Roger Wise, chief radio engineer, Hygrade Sylvania of the improvements in tubes occurring within the past year. Mr. Wise pointed out that the mutual conductance of present type tubes was materially higher than those of a year or so ago, the average being nearer 1500 micrombos compared to the older figure of 1000. This improvement resulted from the use of better cathodes, smaller spacing and better mechanical jobs. The plate voltage limits have been increased in the case of many tubes with resultant increase in power output. Tubes which were designed for 180-volt operation are now rated at a maximum of 250 or even 300 volts. Bulb temperature and wattage dissipation had been doubled in recent years. Research on new metals and new insulators has improved the tube not only in characteristic but in life expectancy.

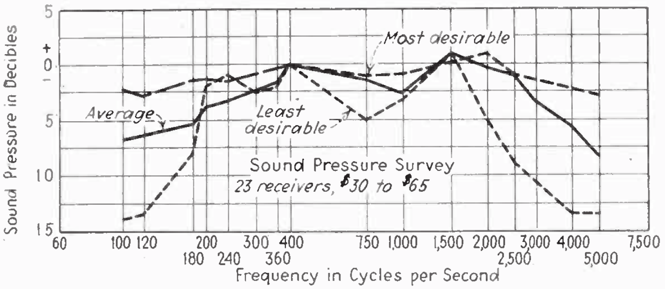
Tubes have been developed which will stand considerable voltage overload. For example, the first heater type tubes were sensitive to voltage variation and much trouble was experienced in locations where the line voltage varied through even fairly narrow limits. Now tubes will withstand terrific overloads. The 6.3-volt series is a good example. These tubes have good life even on 8.5 volts and in some laboratories are consistently life-tested at this voltage.

Cathode operating temperature has been reduced with corresponding increase in life. According to Mr. Wise, the power expended was formerly of the order of 25 watts per square inch of cathode area. This has been successively reduced to 18 and is some cases to 12 and 15 watts per sq.in.

Leakage currents are only 10 per cent of those experienced before circuits were devised which put a high voltage between cathode and heater. Grid and gas currents have been decreased, both factors which have improved the tube at considerable expense on the part of the tube manufacturer.

Dynamic detection

Running true to form, Kenneth Jarvis of Zenith Radio, got off the beaten path and disclosed new and most interesting possibilities. Readers will remember that at the Fall Meeting of 1932 (See *Electronics*, December, 1932, page 368) Mr. Jarvis suggested that additional services be put in broadcast receivers, possibly operated from the broadcast station by utilizing the frequency between the carrier and the lowest audio frequency used, say between zero and 40 cycles.



Average priced receivers have reasonable fidelity as this NAB survey shows

At the same time Mr. Jarvis discussed the possibility of a detector which would not only tolerate overmodulation but might enjoy it. At this year's meeting he disclosed to some extent the work he has done in this direction. He indicated how a fading carrier could be brought back to its proper strength at the receiver and thus eliminate some of the distortion resulting from selective fading.

In connection with the additional service idea, it is worth noting that fascimile systems have been developed which could get their impulses from a broadcast station without interference to the regular program, or during the night hours when the musical programs are not on the air with the result that a facsimile newspaper could be delivered to every home. The cost of such systems available at the present time is low; the quality good enough to show cartoons or advertising in addition to type.

Receiver control from transmitter

An experiment in using the band of frequencies between the carrier and the lower limit of the audio spectrum has been tried in the Middle West. This is a system for turning on a radio set by a signal emitted by the broadcast station. This signal would be inaudible, appearing in the band below the lower limit of audibility and of very low level. This experiment (see this issue of *Electronics,* page 327) has many applications, as can be seen from the original experiment, verifying Mr. Jarvis' prognostications of a year ago.

Since these lower audio frequency circuits can be made very selective it may not be too much to expect several services in this nether audio region. Perhaps the future will see radios equipped with various buttons which, when pushed, will automatically set the receiver for the first jazz (or speech) program that comes along. Thus many of the impromptu programs of wide national or local importance which come on the air and disappear, unheard, would be called to the attention of the set owner, automatically.

Mr. Ralph Langley has suggested that a time clock in the radio could turn on the set automatically for fifteen seconds, or so, at the beginning of each quarter hour period. The set would turn itself off if the listener did not desire the program to continue. Therefore, if the broadcast station had an important message it would be delivered in this 15-second interval; the listener would hold the program as long as desired.

By this automatic system the listener would push the button for the type of program desired; when it came along the set would be turned on from the broadcast station and would continue for fifteen seconds unless the listener desired to hear the remainder of the program.

Two papers which attracted considerable attention from the engineers in attendance were given by I. G. Maloff, RCA Victor, on television and by William S. Barden and David Grimes, RCA License Laboratory, on super-regenerative circuits. Because these papers are being prepared for publication in *Electronics,* they will not be reported in detail at the moment. Little of quantitative nature has been published on the super-regenerator since Major Armstrong's original disclosure in the *Proceedings of the IRE* in 1922. Therefore this paper giving quantitative data on the amplification possible, methods of control, the effect of varying the quenching frequency, etc., was given close attention.

The super-regenerator is a circuit of great importance now that stations are being located in the region below 10 meters wavelength. The Bayonne, N. J., police radio system installed by Radio Engineering Laboratories uses this circuit successfully on eight meters (approximately), and it is safe to assume that its use will grow rapidly.

The paper by I. G. Maloff on television problems focussed attention to the fact that the paucity of details regarding progress in the television art gives the impression that little is being done to advance the day when television will aid in bringing radio out of the red. This lack of progress is only apparent; progress continues at a rapid rate considering the tremendous problems.

Mr. Maloff's paper will be reported in greater detail in a future issue of *Electronics.* It will outline some of the problems of modulating the beam of a cathode ray tube, give concrete examples of types of tubes to be used, the amount of power necessary and methods of solution of several other important problems.

Mr. Maloff indicated that because of the difference between horizontal and vertical resolution, the band width actually required for a high-fidelity picture would not be so great as was once thought.

It seems, therefore, that the technical details of television are not too far from solution. The terminal equipment, although expensive, would become much cheaper with a volume market. On this score many pessimists still doubt the ability of a cathode ray picture to hold the attention of an audience. It may be said that many thousands of listeners follow a football game or other event with great attention; certainly the addition of sight would not detract from such entertainment.

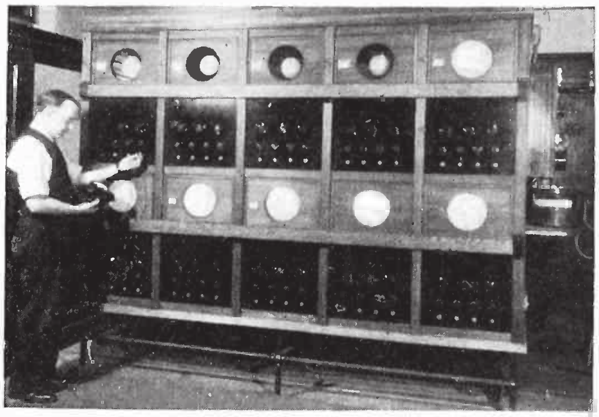
Modern cahode ray tubes (see page 332 this issue of *Electronics*) are large in size, have great brilliance of image, are capable of a finely detailed picture, and have a long life. At present they are very expensive considered as instruments for the home, but these prices would come down if they could be made in thousand lots.

At the meeting of the television committee (RMA) a recommendation was made that the RMA encourage the Federal Radio Commission to open the band between 42 and 110 Mc. to television.

Automobile interference problems

An excellent presentation of the entire problem of ignition interference to broadcast programs either to radios in the car or near highways was given at the Fall Meeting by L. F. Curtis, United American Bosch. The virtues of proper filtering, of shielding, and use of clean spark plugs came from the paper and from the later discussion. It was pointed out that high test gas using lead tetraethel breaks down into various products some of which deposit on the spark gaps and lower the resistance appreciably. This lowering of resistance makes the spark suppressors installed in the car interfere with the proper functioning of the car at some speeds.

Cathode ray tubes for oscillograph purposes



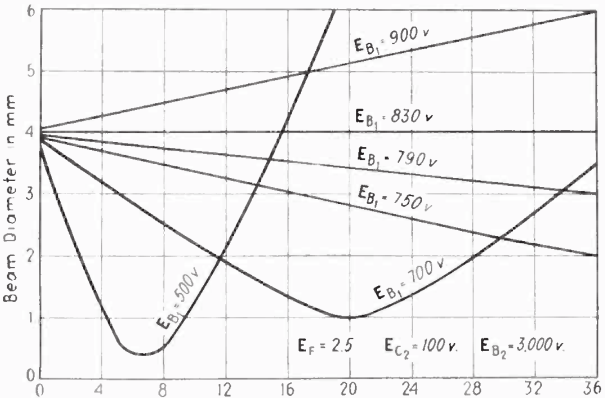
A battery of cathode ray tubes on life test

By C. W. TAYLOR, L. B. HEADRICK and R. T. ORTH

RCA Radiotron, Inc.,
Harrison, N. J.

THE field of application of cathode ray oscillographs is daily being enlarged to include new uses in laboratory measurements and industrial engineering study. The common faults of cathode ray tubes have been short life, non-uniformity, insufficient brilliance of pattern, poor control of brilliance, and most of the tubes required critical adjustment and were awkward.

In studying the above difficulties, it was apparent that the choice between a high vacuum tube and an inert-gas filled tube should be given first consideration. In a gas-filled tube, positive ion bombardment of the oxide-coated cathode shortens the life of the tube considerably. It should be mentioned also that the oxide-coated cathode is desirable because of its low-operating temperature, which reduces the possibility of any light from that source conflicting with the fluorescent pattern.



Focussing effect of the second anode voltage

By evacuating the tube to a pressure of about 10^{-5} mm. mercury, a relatively high vacuum results in which positive ion bombardment of the cathode is minimized. Gas filling presupposes the use of the gas as a focusing means to confine the beam to a narrow pencil of electrons. While the exact mechanism of gas concentration is not yet clearly understood, a review of the action has recently been given by on Ardenne.[1] The determining factors, however, in forming a gas concentrated electron beam are quite clearly understood, and are outlined by E. Bruche[2 & 3], as determined by the kind of gas, gas pressure, current strength, and the construction of the accelerating electrodes and the strength of the resulting field. To obtain focus in a particular tube, therefore, it is necessary to adjust the current to its crtical value for the particular operating voltage conditions. This makes it difficult to control the light intensity. Again, it is difficult to manufacture gas-filled tubes because of the small amount of gas necessary to obtain gas focusing (of the order of 10^{-3} mm. Hg), and because of this small amount of gas it is also difficult to keep the pressure of gas from changing during life, due to loss or addition from the glass walls or metal parts. All of these difficulties lead to the choice of a high vacuum tube. Here, however, the addition of a focusing mechanism is necessary to take the place of the gas concentration.

Either magnetic or electrostatic fields or both may be used to focus the beam of electrons to a small spot. The theory of magnetic concentration has been developed by H. Busch[4 & 5] and Thibaud.[6] The theory of electrostatic focusing has been outlined by V. K. Zworykin[7]; papers describing experimental work have been published by Knoll and Ruska[8]. To focus fast-moving electrons magnetically requires considerable power in the magnetic coil which is placed coaxially around the tube neck. Therefore it is often desirable to use electrostatic focusing, which is dependent almost solely on the ratio of voltages applied to two of the electrodes.

Methods of deflecting the beam

The beam of electrons as accelerated out of the electron gun and focused on the screen may be deflected either by magnetic or electrostatic fields. To move the spot vertically and horizontally over the screen, it is necessary to apply two fields whose forces are at right angles. These separately applied fields of force may be magnetic, or electrostatic, or a combination of the two. It is possible to deflect in both directions magnetically with the fields applied at the same point along the electron trajectory. It is, however, more difficult to obtain a distortionless pattern with electrostatic deflection in both directions when the fields are applied at the same point, but it is quite simple to deflect first in one direction and then the other by displacing the deflection plates along the length of the bulb neck. The combination of electrostatic deflection in one direction and magnetic deflection in the other direction is often best when it is highly necessary to eliminate distortion. In combining the two methods of deflection, both fields may be applied at the same point along the electron trajectory without any trouble from interaction beween the fields. The advantages of such methods are that both the deflection plates and magnetic poles may be made small, and yet the fields are practically uniform for maximum deflection in any direction. From the tube standpoint, other effects should be mentioned in considering the modes of deflection which include spot size, defocusing of spot under deflection, distortion of pattern, and the deflection sensitivity of the tube at the operating conditions for the frequency under study.

Since these considerations are from a tube manufacturing standpoint only and since there are many secondary effects involved, they will not be discussed here. However, it is well to consider the types of deflection from an application standpoint. Electromagnetic deflection is practical up to the frequencies of 10^4 cycles. Electrostatic deflection is the best and simplest when frequencies above 10^4 cycles are being studied. However, if ultra-high frequencies of the order of magnitude of 3×10^9 cycles are being measured, even the deflection plates may give difficulty, due to a very high frequency being applied to a relatively slowly moving electron beam. The result may be phase distortion or low or even zero deflection sensitivity. The design of a good magnetic circuit to give deflection in both directions without spot, pattern, or wave shape distortion, is difficult. Most any simple magnetic circuit may be used, however, to give good deflection in one direction, taking the usual precautions in designing any magnetic yoke with regard to soft iron and laminations and uniform field shape. In most applications, the frequency may be applied to the deflection plates and the lower-frequency timing wave may be applied through the magnets.

We shall now consider the gun. The cathode is oxide coated and of the unipotential type, heated by a non-inductive heater coil. It is surrounded by a control electrode or No. 1 grid. The amount of current drawn from the cathode is determined by the negative bias on this grid. A nominal positive potential on the No. 2 grid, or accelerating electrode, gives the emitted electrons their initial acceleration toward the screen. The field shape in this region also tends to bring the beam to focus. However, the main focusing field is between the No. 1 and No. 2 anode. The No. 2 anode is the high voltage electrode which gives the electrons their final energy for producing fluorescence of the screen. For focus, the No. 1 anode is run at between $\frac{1}{4}$ and $\frac{1}{5}$ of the positive potential on the high voltage electrode. For a particular gun structure, the ratio of anode voltages for focus remains constant independent of their magnitude. Briefly, the path of the electrons from cathode to fluorescent screens is initially convergent through the control electrode, passing through a focus in the region of the accelerating electrode. From here, they diverge to the main focusing field, where they are again made to converge, but this time at a point on the fluorescent screen. Those electrons which are too divergent to be focused by the main focus field are stopped by a beam-defining aperture in the No. 1 anode. In some gun structures, the accelerating electrode is omitted, and in this case, the No. 1 anode provides the initial accelerating and focusing field for the electron beam.[9]

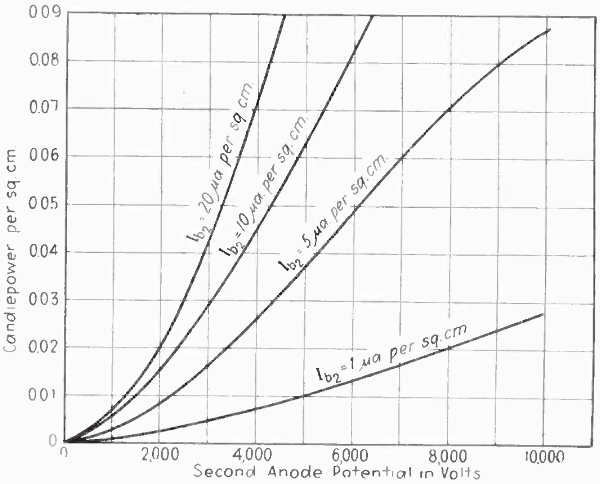
The following general facts and data on high vacuum, electrostatically focused cathode ray tubes employing willemite screens may be of value to those contemplating their use:

1. All tubes should be shielded from extraneous fields, such as the earth's magnetic field, which may cause deflection of the spot away from the axis of the tube. An iron or steel box open at one end, through which the bulb screen may project, is usually sufficient. This box should be electrically connected to ground.

2. The tube may be operated either with the cathode grounded and the No. 2 anode and deflection plates above ground, or with the latter grounded and the cathode and other electrodes below ground. If operated with the cathode below ground potential, care should be exercised in insulating the heater from ground as well as the other gun electrodes.

3. Since the size of a focused spot is almost directly proportional to the square root of the current in the beam, where extremely accurate measurements are being made it is well to reduce the beam current to the minimum, depending upon requirements of pattern brilliance.

4. The screen brilliance is affected by the fluorescent screen efficiency and by watts input to the screen. Since the light output increases with No. 2 anode voltage, it would seem wise to run this potential up to the maximum rating for the tube; from the standpoint of deflection sensitivity, however, the reverse is true and a compromise must be effected.



Average fluorescent screen characteristics

5. Electrostatic deflection sensitivity for a particular pair of deflection plates is inversely proportional to the No. 2 anode potential. The sensitivity is usually expressed in mm. deflection of the spot on the screen per volt impressed across the deflection plates.

6. Magnetic deflection sensitivity for a particular tube with a particular magnetic circuit is inversely proportional to the square root of the No. 2 anode potential. The magnetic deflection sensitvity is usually expressed in mm. deflection of the spot on the screen per gauss of magnetic field intensity. Since magnetic deflection sensitivity is dependent upon the external magnetic circuit and its position along the neck of the tube, the following expression is given to aid in the design and placing of the magnetic circuit:

$$\text{Magnetic Sensitivity} = \frac{d}{H} = \sqrt{\frac{e}{2E_{b2}m}}\left(X_1X_2 + \frac{X_1^2}{2}\right)$$

d = deflection in centimeters
H = deflection field intensity in gauss
X_1 = length of pole pieces in cms
X_2 = distance from poles to screen in cms
E_{b2} = second anode potential in stat-volts (1 stat volt = 300 practical volts)

[*Please turn to page 339*]

HIGH LIGHTS ON ELECTRONIC

Skylights controlled for uniform illumination

THE NEW FEDERAL POST OFFICE at High Point, N. C., is equipped with skylight louvres which are motor-controlled from photocells so that a uniform intensity of light is maintained throughout the day, on the working plane in the mail-sorting room, in spite of changes in natural lighting or the position of the sun.

The principal photocell unit is located on the roof, facing north, and serves to open the louvres wide as long as there is light in the sky. Other photocells control the banks of shutters, to deliver uniform intensity in front of the sorting racks. The installation has not yet been turned over by the contractors, and full information is not available. It seems likely from the improved working conditions obtained by photocells in this installation, that similar light-controlled shutters may be installed in many other post offices throughout the country.

◆

Amplified voice of law makes motorists beware

By DR. E. E. FREE

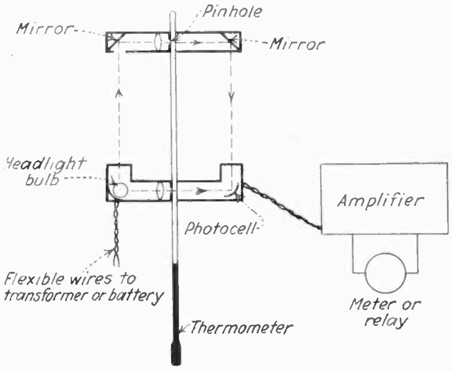
HOW RADIO HAS PROVIDED a "loud voice of the law" in Wichita, Kansas, to supplement its proverbial long arm is described by Mr. Harry Barsantee in a recent announcement of the National Safety Council, of Chicago. In one of the Wichita police trucks Police Lieutenant Ray Ashworth has mounted a microphone, an amplifier and a powerful loudspeaker. The microphone hangs just beside the officer driving the truck, so that whatever he speaks into it may be boomed out with the voice of a thousand traffic officers from the loudspeaker atop the truck. Persons attempting to cross the street contrary to traffic regulations, motorists about to make a wrong turn at a corner, truck drivers preparing to park illegally and similar would-be violators of regulations are likely at any moment to hear a stentorian voice call their attention and the attention of every bystander within a block or two, to the errors about to be committed. The officer in the police truck, cruising somewhere in the neighborhood, has noticed what was about to happen and has spoken the necessary warning into his microphone. Mr. Barsantee reports that results have been most salutary not only in stopping the individual violations thus called to public attention but in making all users of the streets more careful for fear that the accusing voice of the law is somewhere about. At fires, parades and similar occasions the outfit also has proved its value in handling crowds issuing instructions to officers and the like.

◆

A photo-cell thermometer

THE ACCOMPANYING SKETCH illustrates an application of a photo-cell extending an idea which appeared in the March, 1933, issue of *Electronics*. Two beams of light instead of one are employed in this apparatus.

Such a split-beam is useful in experimental work where the temperature change between two points is to be timed with a stop watch. When the mercury column intercepts the first beam, the pointer of the meter will deflect; when it passes through the second beam the pointer will deflect still further; to zero, if the cell is connected in the usual manner. It is more convenient to watch the meter for the decreases in the current than it is to decide with the eye when the mercury column passes a given point, even though a lens may be used.



A double light-beam method of noting thermometer changes for accurate timing

Referring to the drawing, we see that there are two light heads on the thermometer. The lower one houses an intense source of light, which in this case is a double-filament headlight bulb, tilted so the maximum amount of light will be transmitted to the photo-cell which is housed in the same unit. Both filaments of the bulb are used at the same time. The photo-cell is also tilted to receive both of the beams of light, one through a pinhole, similar to the pinhole in the upper light unit, and the other by the reflected route.

The upper light head merely guides the vertical ray of light through the second pinhole. Both light units are adjustable up and down. The meter may be replaced by a relay to enable the apparatus to be used as a thermostatic control. The relay may be used also to actuate a clockwork timer, in case the time of the passage of the mercury column between the two light beams is excessively long.

If the thermometer be replaced by a liquid gauge containing a suitable float, the split beam system may be used to regulate the levels of liquids. Once the apparatus is in use, other applications will suggest themselves.

◆

Light levels demonstrated by sound changes

IN CONNECTION WITH HIS LOCAL campaign for better lighting, J. E. North, manager of the Electrical League of Cleveland, wanted some way to demonstrate changes in lighting levels when different sizes of lamps are switched on.

The volume level of a radio set was finally selected as the means of showing this change. Accordingly a photocell was installed in the light of the lamps to be demonstrated. This photocell controls a relay which switches the radio set on loud or soft.

With a 25-watt lamp turned on, the radio set plays faintly and indistinctly, and it is pointed out that reading by such a light is similarly unsatisfactory. But when a 100-watt lamp is lighted, the increased light flux causes the photocell to switch on the radio receiver to loud clear tones, with every instrument clearly heard, comparable to the clear, distinct and easy vision possible with plenty of light.

Visitors to the Electrical League's showrooms in the Builders Exchange Building, Cleveland, can thus switch the lamps high or low, and observe how the radio music instantly follows in volume and clearness.

◆

Photo cells dependable over long service

FRED J. BROWN of the lighting service department of the Syracuse (N. Y.) Lighting Company, reports that for the past three to four years his organization has had three photocell control units in continuous service—two to control the illumination of gas holders and the third to turn on a flood-lighting installation. "Our experience has been almost perfect on these applications," reports Mr. Brown.

DEVICES IN INDUSTRY + +

Rectifier tubes supply Boston direct-current system

ELECTRONIC TUBES, HAVING NO moving parts, have replaced larger and bulkier rotating machinery for rectifying alternating current into direct current, in a substation of the Edison Electric Illuminating Company, Boston. Silent operation, high efficiency, and economy in floor space are made possible by the equipment.

The installation in the Salem Street substation, in downtown Boston. The equipment, designed and built by the General Electric Company, makes use of six Phanotron tubes. The electric energy from the power company's system enters the substation as 13,800-volt, three-phase, 60-cycle current, and is changed into direct current at 238 volts. The energy thus transformed is delivered to the distribution cables to supply residences, office buildings and stores.

At any point where it may be desired to establish a connecting link between the alternating current supply and the direct current distribution system, such a rectifier offers a compact, automatic substation in itself. Investment in real estate for substations, a serious consideration in congested business districts, may be greatly reduced, if not eliminated altogether. The small space required, coupled with absence of noise and vibration, sometimes objectionable characteristics of rotating equipment, will permit these installations to be made in places heretofore not available.

The tubes now operating at Salem Street employ a metal type of construction, in that the cathodes are enclosed within a cylindrical shell of copper, thus reducing the use of glass to a minimum and resulting in a sturdy powerful tube capable of withstanding the shocks of service conditions.

Such rectifier equipment is applicable in connection with Edison three-wire systems, and in other cases where it is desired to convert alternating to direct current.

◆

Radio-acoustic sound ranging locates submarine peak

CAPTAIN R. S. PATTON, director U. S. Coast and Geodetic Survey, announces that the survey ship *Guide*, now engaged in hydrographic work off the California coast, reports the discovery of a submerged mountain lying about 52 miles southwestward from Point Sur.

This remarkable feature rises from depths of about 2,000 fathoms, and is ten miles long in a north and south direction.

If the ocean were to be drained, this formation would show up as an isolated mountain 7,500 feet in elevation. The position of the submerged peak was accurately determined by means of radio acoustic sound ranging, from stations on the California coast.

Duplicate generating sets for airfields started by cell

IN PROVIDING AIRPLANE BEACONS and landing fields with lights which come on at darkness, in remote locations where no power-supply lines exist, it is necessary to employ gas-engine-driven generating sets. The photocell must then automatically start up the engine-set and get it into operation, instead of merely switching on a local lighting circuit.

Complete starting apparatus for duplicate gas-engine sets is now being operated successfully by a Westinghouse photocell unit on the beacon near Pitcairn, Pa., on the airway to Washington. When darkness falls, the photocell first turns cranking current into the No. 1 set, turning it over for a predetermined time. If this engine does not start, the machine then switches over to the No. 2 duplicate of No. 1, and cranks it. If this also fails to start after an interval, the current is turned back to No. 1 again, and so on. Usually one or the other unit starts up promptly, and then continues to run until the photocell shuts off the circuit at dawn.

With this new photo-sensitive control starter, automatic beacon lighting can be provided anywhere, even in the most isolated regions, far from power lines.

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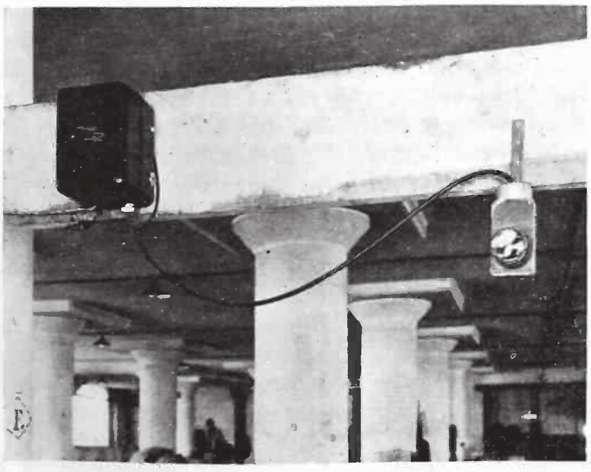
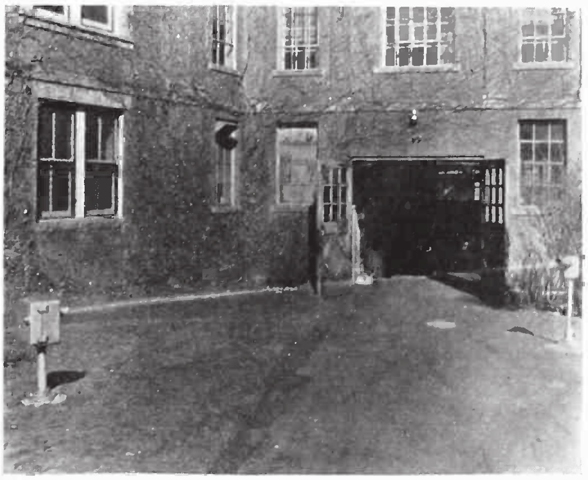
SELF-OPENING SHIPPING DOOR



Instead of "crashing open" the doors through which hand-trucks pass, the shadow of the trucker on this ceiling photocell, opens the doors quickly and noiselessly

TRUCKS OPEN FACTORY DOOR



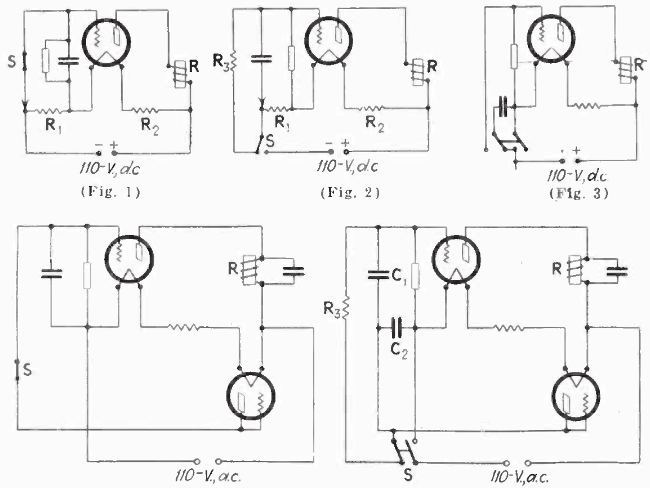
Big auto trucks used to get out of control, roll down this incline, and smash these doors of the Stanley Works, New Britain, Conn. Now a light-beam opens the doors if a truck appears

Vacuum tube delay circuits

By M. W. MUEHTER

MANY uses have been made of the fact that the charge in a condenser, and hence the voltage across it, changes slowly when appreciable resistance exists in the circuit. A good example is a delayed relay operation, particularly if the circuit must have a quick-reset feature which is difficult to attain with thermal or mechanical relays. Introduction of large capacities in the form of electrolytic condensers has materially improved the time limits over which control is possible; application of vacuum tubes to this field has again greatly enlarged the uses of condensers shunted by resistors or in series with them.

Since the plate current of a tube can be controlled without any energy expenditure as long as the grid is kept negative with regard to the filament, the tube and the relay connected in its plate circuit will not affect the charging or discharging time of a condenser connected to its grid circuit. Under such conditions, the timing reaches a practical limit by the energy consuming insulation of the condenser itself and the associated circuit and can be made considerably longer, up to several minutes with a few microfarads. As the timing depends on the time constant CR, condensers should be used in which the ratio R/C is high, which means low leakage condensers. The actual limitation is usually given by the associated circuit, the insulation of which cannot be maintained above certain values, say 10 megohms.



(Fig. 1) (Fig. 2) (Fig. 3)

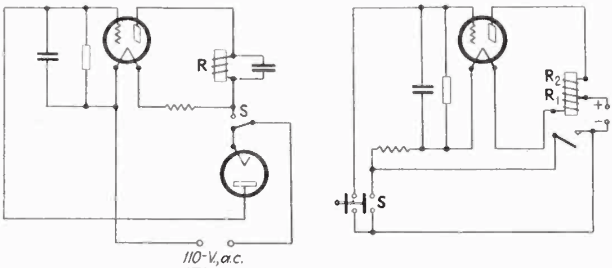
(Fig. 4) (Fig. 5)

Fig. 1—Simple time delay circuit. Fig. 2—Method of saving filament life. Fig. 3—Circuit for obtaining longer delay. Fig. 4—Operation on a.c. Fig. 5—Circuit in which filaments are normally not heated

Most frequently it is desired to obtain a secondary operation after a predetermined time has elapsed since the initial operation. Figure 1 shows a simple d-c arrangement. The tube is normally heated, one of the filament series resistors supplying the plate voltage, the other keeping the condenser charged through switch S. As long as S is closed, the grid of the tube is strongly negative with regard to the filament and no plate current flows. When S is opened, the condenser slowly discharges through the shunt resistor, causing the grid to become less and less negative. At a certain negative grid voltage the relay operates. When the switch is closed again, the condenser is recharged and the grid becomes negative, causing the relay to drop back.

A disadvantage of this circuit is that the filament of the tube is always heated. The circuit in Fig. 2 avoids this. Here switch S is of the throw-over type. When S is thrown in the operated position, the tube circuit is closed and the filament heats up. The condenser is slowly charged through the grid leak. The grid potential is strongly negative at first and becomes gradually less so, until the relay operates. Resistor R_3 serves to limit the arcing, when the switch is restored to normal.

By using a potentiometer instead of R_1 in these two circuits and connecting S or the condenser respectively to the moving contact, the timing can be easily varied. Both circuits have the disadvantage that only a relatively small voltage is available for the condenser, as most of the 110 volts has to be used for the plate. In Fig. 3 the condenser is charged to 110 volts, thereby obtaining a longer delay. However, a double-pole switch S is required. Obviously the place of this switch can be taken by a set of contacts operated by another relay. When the switch is operated, the tube circuit is closed and the condenser connected to the grid circuit in such a way that the grid is negative. When the condenser has discharged through the grid leak, the relay operates.



(Fig. 6) (Fig. 7)

Fig. 6—Method of using glow tube for charging condenser. Fig. 7—Circuit for maintaining an operation

Figure 4 shows an arrangement for a.c. Two tubes are used, one for the operation of the relay, the other to supply the charging current for the condenser. To spare a filament transformer, the filaments are operated in series with each other and a resistor on 110 volts. Both filaments are normally heated, but no current flows through the relay, as the condenser is kept negatively charged on the grid side through switch S. When S is opened, the relay operates, after the charge has dissipated.

Figure 5 illustrates another a-c circuit, where the filaments are normally not heated. When switch S is operated, current is supplied to the tubes. Condenser C_2 is charged rapidly, while C_1 is charged slowly through the grid leak. As the charge on C_1 increases, the grid

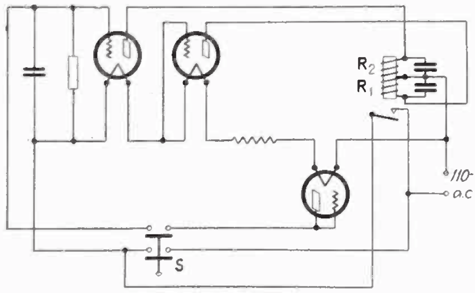
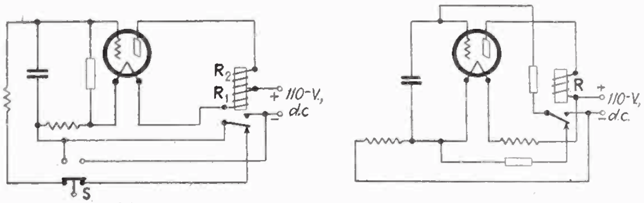


Fig. 8—Maintained circuit for a.c.



(Fig. 9) (Fig. 10)

Fig. 9—Fixed duration impulse circuit. Fig. 10—Interrupter circuit

becomes less negative; finally the relay pulls up. C_2 serves to maintain the negative charging potential during that part of the a-c cycle, when no current flows in the plate circuit of the charging tube.

If a glow tube is used for charging the condenser, the circuit can be so arranged, that the discharging time is utilized and the filament of the main tube is normally not heated. This is indicated by Fig. 6.

Maintained operation

Another application frequently encountered is to maintain an operation for a predetermined time, after the starting impulse has stopped. The preceding circuits could be used for that purpose, if the operated position of the switch is used as the normal position. The relay would then be normally energized. When the switch is momentarily thrown over to the position shown, the relay drops back and remains so until the end of the predetermined time. These circuits, however, would have the disadvantage, that the tube filaments would normally be heated.

Figure 7 shows a circuit for d.c. where this is not the case; its operation is based on Fig. 1. The relay has a double winding. When the double-pole switch or push-button is operated, the filament is energized in series with relay winding R_1. A series resistor may be used in addition, if the voltage drop across R_1 is not sufficient. The relay pulls up and locks the circuit in through its own contact. The second contact of the starting button charges the condenser negatively with respect to the grid, so that no plate current can flow. When the button is released, the relay stays in the operated position, until the condenser has discharged. Plate current then flows through the second relay winding opposing the first and causing the relay armature to release. The relay opens its locking circuit and restores the controlled circuits to normal.

Fixed impulse operation

An arrangement for a.c. is indicated by Fig. 8, based on Fig. 4. Another tube is used to rectify the current for winding R_1, as otherwise no compensation of the two relay windings would be possible.

If it is desired to obtain an impulse of fixed duration regardless of the length of the initial impulse, a circuit according to Fig. 9 may be used; it is based on Fig. 2. When S is operated the relay pulls up through winding R_1 and locks in through its contact. When the condenser has been charged, winding R_2 is energized, causing the relay to drop back. If, by that time, the switch should still be in the operated position, nothing further happens, until the switch is restored, discharging the condenser and making the equipment ready for the next operation. A corresponding circuit can be evolved for a.c., based on this and the preceding circuits.

Electron-tube interrupter

An interrupter arrangement is shown in Fig. 10. Upon starting, the grid has zero potential and the relay pulls up transferring the condenser circuit to the charging position. The plate current now drops, until the relay releases, causing the condenser to discharge through its back contact. Then the relay picks up again and so forth. The timing depends on the difference of the operating and release currents of the relay, as the plate current oscillates between these two values only and never becomes zero. A corresponding circuit may be used for a.c., employing a charging tube. For very slow operation a double-tube circuit can be designed, one tube giving the delay for one half of the operation, the other for the other half, the condenser always completely charging and discharging.

Design characteristics

The tubes best suitable for the suggested circuits are the 112A and the 230 type; the former matches better with standard relay coils, the latter has lower filament consumption (60 instead of 250 ma.).

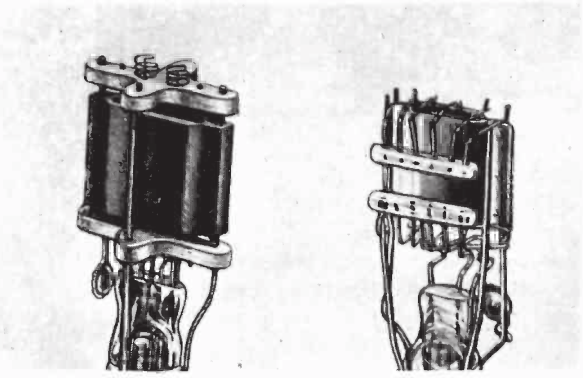
The timing obtainable with the various circuits depends on the constancy of the supply voltage and the permissible variation in timing resulting therefrom. A higher supply voltage increases the condenser charge and would lengthen the time required for the negative grid potential to drop sufficiently, if the plate voltage would not also be higher, allowing sufficient plate current to flow at a higher negative grid potential. This has the advantage that the timing can be kept very constant even on a fluctuating line voltage. Assuming a voltage variation from 90 to 120 volts and using a 112A tube and a telephone type relay the maximum timing for Fig. 1 is about 3 seconds per megohm and microfarad with a variation of only 7% in the timing. Allowing 15%, it would be about $4\frac{1}{2}$ sec. A less fluctuating voltage would give longer delay for the same variation and vice versa. About the same data apply to circuit No. 7. Circuits in Figs. 2 and 9, which utilize the charging time, will also give about the same timing, as long as the insulation resistance of the condenser is high with respect to the grid leak. The effective resistance in the time constant CR is the resistance resulting from connecting both in parallel, as can be derived mathematically.

With Fig. 3 the maximum timing is about $3\frac{3}{4}$ seconds with 7% variation. To obtain this the relay has to be made less sensitive or a tap has to be made on the filament series resistor for a lower plate voltage. In the a-c circuits Figs. 4, 5, 6 and 8 the condenser is charged to the peak voltage, while the mean d-c plate voltage is 45% of the a-c voltage. The timing is about 4 seconds for 6% variation on 90/120 volts a-c, always per megohm and microfarad. If the voltage is stepped up by a transformer, which also could supply the right filament voltage, the timing could be increased.

Graphite anodes in transmitting tubes

By D. E. REPLOGLE

Hygrade Sylvania Corporation,
Clifton, N. J.

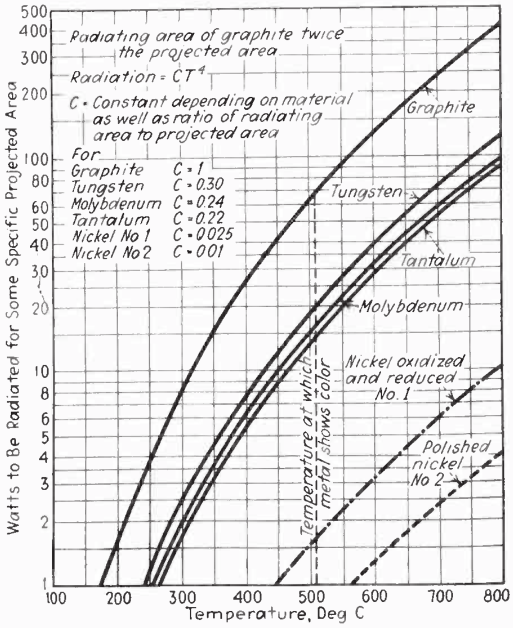


Contrast of graphite anode and conventional mount in type 211 tubes

FOR several years tube engineers have recognized the advantages of carbon for vacuum tube anodes. Witness the early attempts to use carbonized anodes in receiving tubes and the later use of carbonized nickel in receiving tubes where anode dissipation was appreciable. Carbonized metal anodes have the advantage that they will emit a greater amount of heat than any plain metal anode such as polished nickel, oxidized nickel, tantalum, molybdenum or tungsten.

Carbonized metals were impractical in transmitting tubes due to the fact that the carbonizing could not be made perfect enough to prevent the material from flaking off and depositing either on the bulb where it cut down the total heat radiation or on the filament where, due to the heat emission properties of carbon, it would cool the filament below the proper temperature and thus reduce electron emission. Furthermore, it is necessary in high powered tubes to use a metal which has a high vaporization temperature. This has restricted the metals obtainable to tantalum, molybdenum and tungsten.

Of these three metals, molybdenum has served best for anode material because it could be worked and vaporized only at very high temperatures. It had one drawback, however—it was impossible to get perfectly homogeneous specimens of the material. Therefore, anodes were apt to warp when heated in the exhaust positions or in ordinary operation where heat might set up uneven stresses throughout the material. To overcome these troubles elaborate systems have been worked out for bracing molybdenum anodes in all power tubes of 50 watts or over. The most practical has been the "I" beam construction.



Comparative radiation of anodes made from graphite and other materials

Advantages and disadvantages of carbon anode tubes

The following advantages make transmitting tube design engineers desirous of using some form of carbon for anode construction in tubes of 50 watts or over.

1. Greater heat emission properties.
2. Homogeneous structure which does away with strains and warping during manufacturing processes.
3. Adaptability to precise machining and close tolerances.
4. High conductivity.
5. Its property of "getter action," i.e., its affinity for absorbing gases when in a proper degasified state.
6. High temperature point of vaporization.
7. Comparatively low cost.

For a number of years experiments on the use of carbon as an anode in transmitting tubes have been conducted, but the following disadvantages always prevented the making of a satisfactory tube:

1. The fact that on all machine carbon a certain amount of amorphous carbon remains on the surface of the anode which flakes off and deposits itself on the glass insulators and filament, causing the troubles mentioned above, together with providing low resistance leakage paths across insulators.
2. The giving off of gases from the anode of a transmitting tube due to the fact that the hydrocarbonates necessary in binding the carbon together break down and give off gases, shortening tube life and preventing its use at high powers.
3. The difficulty of accurately shaping large pieces of carbon for the larger transmitting tube anodes.
4. The difficulty of securing good contact between the carbon anode and the lead-in wire.

Of the above disadvantages the first two mentioned are by far the most important, and it was necessary to evolve a process for absolutely eliminating the amorphous carbon before assembling the anodes in the tubes and of decomposing the hydrocarbonates in the binder so that the graphitized mass of the anode would emit no gases in service and permit no flaking off of the graphitized carbon.

Under the leadership of V. O. Allen a solution has been found which does just this—namely, removes all amorphous carbon from the surface of the anode and also breaks down the binder and graphitizes the carbon mass.

With this step accomplished these engineers, with the carbon manufacturers, worked out a means for machining large blocks of carbon in one piece to accurate dimensions holding a tolerance of better than 0.001 inch. This was a real achievement in that it precluded the necessity for making the anodes in pieces, with the subsequent difficulty of holding them together by rivets. These graphite anodes are held in rigid relation to the other elements by the "I" beam construction wherever possible. These "I" beams give a maximum of mechanical strength with a minimum volume of metal to be degasified.

These experiments have been so successful that carbon or graphite is used in the entire Hygrade-Sylvania line of air-cooled transmitting tubes from the small 20-watt type 210 tube to the largest air-cooled tube, the 851, rated at 1,000 watts output.

To illustrate how graphite anode tubes increase emitting ability, a chart has been compiled showing the comparative heat radiation ability of various metals. It will be noted that at approximately 510 degrees C., all of these metals begin to show a red color. Thus, for the anode selected in this chart, the tube would dissipate 70 watts when made of graphite against 16 watts when made of molybdenum, 20 watts when made of tungsten, and 14 watts when made of tantalum. Or, considering it another way, if a tube with a molybdenum anode will dissipate 15 watts without making the plate red hot; the same tube with a graphite anode will dissipate 60 watts without heating the plate to a red color. These figures leave no doubt about the virtues of graphite.

Due to this greater heat dissipation, the internal structure of a tube is kept much cooler, and the grid and shield grid structures, which are always hard to degasify in manufacturing, are kept several degrees cooler, thereby preventing the harmful effect of secondary emission and the giving off of gases.

Further uses for this special treated graphite are becoming apparent with increased knowledge. One of the most important is the use of graphite for grid structures in water-cooled tubes where they are particularly subject to intense heat, and in special high-frequency tubes now under development which require the use of pure tungsten filaments with their attendant intense heat.

Cathode ray tubes for oscillograph purposes

[*Continued from page 333*]

m = mass of electron = 9.02×10^{-28} gms.
e = electron charge = 1.59×10^{-20} ab-coulombs

From this equation, it becomes apparent that for maximum sensitivity, the poles should be placed as far from the screen as possible along the tube axis. However, the deflection field may not be applied at the No. 1 anode or closer to the cathode than the No. 1 anode without destroying the focusing mechanism. It is therefore necessary to apply the magnetic field beyond the No. 1 anode; one inch beyond is desirable to insure any stray field from penetrating within the No. 1 anode.

7. An intense beam will burn the screen if allowed to remain stationary for a short while on the fluorescent screen. An intense stationary beam may even heat the glass to red heat and puncture the bulb. It is well to have the deflection voltage applied before turning on the cathode ray beam. The cathode ray beam may be completely controlled by turning off or on the No. 2 anode voltage, or the beam intensity may be varied by varying the negative bias on the control electrode.

8. For those who contemplate using the cathode ray tube for ultra-high frequency measurements an expression for the electron velocity may be useful.

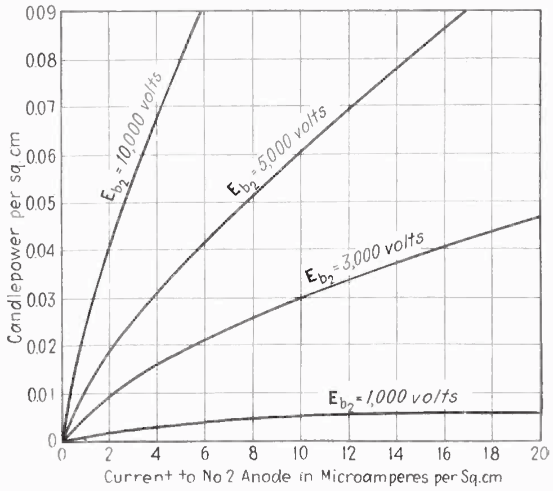
$$\text{Electron velocity} = 2E_{b_2}\,\frac{e}{m} \text{ cms. per second}$$

Eb_2 = second anode potential in stat-volts
e = electron charge in stat-coulombs
m = mass of electron in grams.

The above equation is not absolutely exact, but for electron velocities of less than 10 per cent the speed of light, the error is negligible. Since most cathode ray oscillograph tube beams move more slowly than this figure, the equation may be taken without any correction.

9. For photographic work, persistence characteristics of the fluorescent screen, and spectral distribution characteristics may be of interest.

10. The fluorescent screen nearly always approximates a perfect diffusing screen which follows the cosine law for the distribution of emitted light.



Screen candle power as a function of screen current

1. Manfred Von Ardenne, "*Hochfrequenz-technik und Elektroakustik* 1932, Page 18.
2. E. Bruche, *Zeitschrift für Physik* 78, 1 and 2, Page 26.
3. E. Bruche, *Zeitschrift für Physik* 78, 3 and 4, Page 177.
4. H. Busch, *Archiv für Elektrotechnik* XVIII, 1927, Page 583.
5. H. Busch, *Ann. der Physik*, 81, 1926, Page 974.
6. Jean Thibaud, *Journal de Physique*, Vol. 10, Page 161, 1929.
7. V. K. Zworykin, *Journal of Franklin Inst.* May 1933, Page 535; also *Electronics*, Nov. 1931, Page 188.
8. Knoll and Ruska *Zeitschrift für Physik*, Vol. 78, 5 and 6 Page 318, 1932. Ruska *Zeitschrift für Physik*, Page 684, Vol. 83, 9 and 10, July 1933.
9. A typical electron-path will be found on Page 346, this issue.

+ + ELECTRONIC NOTES

Improved circuits for measuring negative resistance

By Frederick Emmons Terman*

THE NEED FOR A GOOD bridge circuit capable of measuring negative resistances arises in connection with the resistance neutralization method of measuring radio frequency resistance.[1] Several new arrangements for this purpose are shown in Fig. 1. These combine the simplicity of the Dingley bridge[2] together with the capacity balance feature of the Tuttle circuit,[3] and are thus not limited to the measurement of low resistances as Dingley's bridge is, while avoiding the complicated transformer and decimal attenuator required by Tuttle.

In practice the resistance R should not exceed several hundred ohms while R_s should be much greater than R_1. In Fig. 1 (a) R can conveniently be a single turn of resistance wire mounted on the periphery of a 6 to 8 inch disk which is rotated past a fixed contact. In the circuits shown at (b) and (c), R_s can conveniently be a 10,000-ohm tapered rheostat supplemented by one or two decades to extend the range. These decades can be made up from inexpensive wire wound resistance units since a small phase angle produces negligible error.

A practical set up for the measurement of radio-frequency resistance of coils is shown in Fig. 2. The plate potential is adjusted so that the plate current is very small, and is usually near 45 volts. For negative resistances up to 100,000 ohms R_s is connected to tap (a) while by connecting to tap (b) a multiplying factor of 10 is obtained. Actually when the connection is made to (b) one should add 90 ohms to the results, but this is obviously negligible when the resistance being measured is above 100,000 ohms. The capacity balance is obtained by a double stator condenser made by rebuilding a two gang broadcast condenser. The oscillator should have a frequency of 1,000 cycles, and should be capable of developing about one volt. A two-stage amplifier, peaked at 1,000 cycles to suppress harmonics, should be used to detect balance. Troubles from electrostatic coupling between the primary and secondary of the input transformer can be avoided by using a transformer having a single secondary coil wound over the primary. By connecting the inside terminal (commonly marked C-) to the grounded side of the amplifier the inner secondary layer acts as an electrostatic shield which tests show to be just as effective as much more elaborate shielding.

The procedure for operating the circuit of Fig. 2 is as follows: The tuned circuit under test is connected across XX and adjusted to the desired frequency. S_2 is then shorted, thus bypassing the measuring equipment to a-c currents without affecting the d-c voltage applied to the plate. Switch S_1 is opened and the grid bias is adjusted until the tuned circuit is just on the verge of going in or out of oscillation. The oscillating condition can be tested for by means of an oscillating detector, or by watching the plate current microammeter, which always jumps slightly as oscillations start. The switch S_1 is now closed while S_2 is opened, after which the negative resistance is balanced on the bridge circuit. The negative resistance thus obtained is related to the tuned circuit resistance R_s by the relation $R_n = \frac{(2\pi f L)^2}{R_s}$. In this equation L is the inductance of the tuned circuit as measured at audio frequencies or calculated, while f is the frequency at which the circuit goes into oscillation and can be measured by means of a wavemeter or calibrated receiver. It will be noted that unlike all other methods of measuring radio-frequency resistance, no correction is necessary for stray capacities, and no delicate adjustments or special precautions are required to obtain high accuracy.

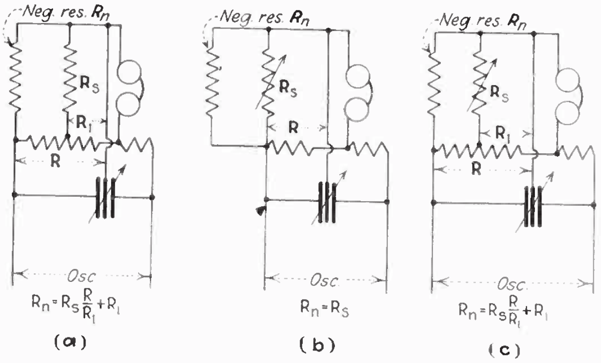


Fig. 1—Possible methods of measuring negative resistance

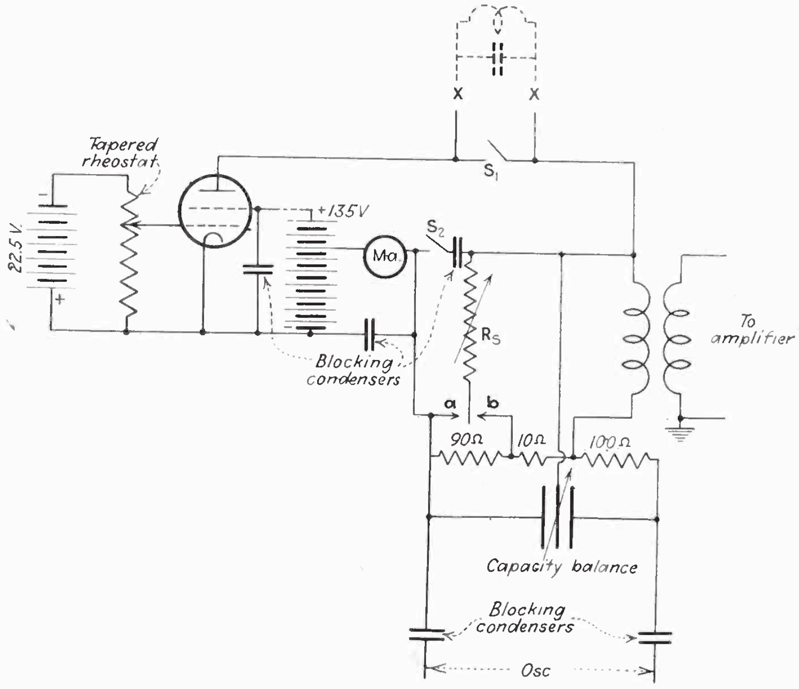


Fig. 2—Complete set-up for determining shunt resistance of an inductance-capacity circuit

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*Stanford University.

[1] See Hajime Iinuma, "A Method of Measuring the Radio-frequency Resistance of an Oscillatory Circuit," *Proc. I.R.E.*, vol. 18, p. 537, March, 1930.

[2] Edward N. Dingley, Jr., "Development of a Circuit for Measuring the Negative Resistance of Pliodynatrons," *Proc. I.R.E.*, vol. 19, p. 1948, Nov. 1931.

[3] W. N. Tuttle, "Dynamic Measurement of Electron Tube Coefficients," *Proc. I.R.E.*, vol. 21, p. 844, June, 1933.

FROM THE LABORATORY ++

Equivalent circuit for tetrodes and pentodes

By W. M. Goodhue*

When the triode originated, it was natural to employ a concept of a fictitious emf. in series with the load and tube impedances, because the concept of emf.'s in general arose from the consideration of power sources. However, if the series circuit is applied to many of the modern tetrodes and pentodes, the fictitious emf. becomes so large that it has no physical significance whatever, and actually becomes inconveniently large in making computations. For example, the type 57 tube has an amplification factor of approximately 1,500. Hence, with a signal of 1 volt, the fictitious emf. becomes 1,500 volts, which is far beyond any voltage which may exist in the circuits. This objection may be overcome by the use of an equivalent parallel circuit, such as is shown in the figure rather than the equivalent series circuit. Moreover, since the plate resistance is extremely high, the impedance of the load is ordinarily small in comparison. Therefore, the *current* may be considered as being impressed on the circuit rather than the emf.

In the figure, G is the mutual conductance of the tube; de_g the differential of impressed grid voltage; Z_p the plate impedance of the tube, and Z_L the load impedance. The load current, or plate current, due to de_g is:

$$di_p = G \frac{Z_p}{Z_p + Z_L} de_g \qquad (1)$$

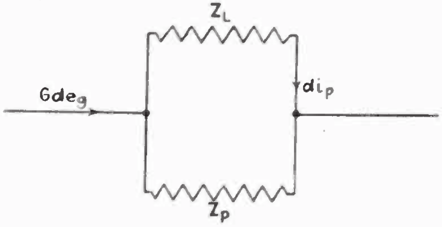
On the usual basis of an emf. acting on a series circuit, the plate current is

$$di_p = \frac{\mu \, de_g}{Z_p + Z_L} = \frac{G \, Z_p}{Z_p + Z_L} de_g \qquad (2)$$

which is the same as equation (1).

The newer type tubes, for example, the 57 and 58, have so high a plate impedance (of the order of 1.5 megohms) that the load usually operates nearly under *constant current* conditions. This makes the use of the equivalent parallel circuit convenient both in viewpoint and in computation. Actually, the plate voltage is held down to reasonable values by the load impedance, *and the equivalent parallel circuit expresses this condition.*

As an example of the quantitative relationships for the equivalent parallel and the equivalent series circuits, consider the type 57 tube, which has a plate impedance of 1.5 megohms. Assuming a load impedance of 100,000 ohms, the fictitious impressed current is 1.23 ma. per 1-volt signal, while the actual plate current and load current are 1.15 ma. The *fictitious* impressed current $G \times de_g$ of the parallel circuit is but slightly greater than the *true* plate and load current, di_p, under the condition of high plate impedance. In the older series-circuit method, the fictitious impressed voltage would be 1,500 volts, whereas the true load voltage would be actually only 115 volts.



Thus, the equivalent parallel circuit is advantageous in that the fictitious impressed quantities are practically equal to the actual physical quantities. This circuit is applicable equally to ordinary triodes, although because of their low values of amplification factor, no advantage results in its use in such cases.

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The side bands occurring in frequency modulation

E. D. Scott and J. R. Woodyard of the University of Washington, describe the Bulletin of the Engineering Experiment Station (No. 68: 5-24, 1933) experiments on frequency modulation.

In pure frequency modulation the amplitude of the wave is kept constant, but its normal frequency h is varied periodically, the amount of the variation depending on the intensity s of the sound and the period of variation being equal to the applied audio frequency L, so that the antenna current is given by an expression of the type $I \sin (6.28\, ht - sh \sin 6.28\, Lt)$. This may be written as the sum of carrier current and a large number of side bands, spaced by multiples of the modulation frequency L above and below the carrier frequency h, the amplitudes being successively proportional to the Bessel functions of successive orders J_0, J_1 J_2 . . . of sh/L. The higher orders decrease rapidly in strength. The existence of these bands was verified for the first time by using part of a Baldwin type loudspeaker as condenser plate for modulating the frequency. To separate the side bands reproduced in the receiver, a sharply tuned audio-frequency circuit was used to apply the signal to the measuring device, the incoming wave being made to beat with a separate crystal controlled oscillator. From three or four to as high as seven side bands could be isolated and measured.

Table for solution of impedance problems

Engineers who have occasion to calculate the square root of the sum of the squares of two numbers, a tedious if not laborious operation, will be interested in a table of the values of K in the following equation which may be used with the slide rule to materially lessen the tedium of such calculations.

$$\sqrt{A^2 + C^2} = C \sqrt{1 + \left(\frac{A}{C}\right)^2} =$$

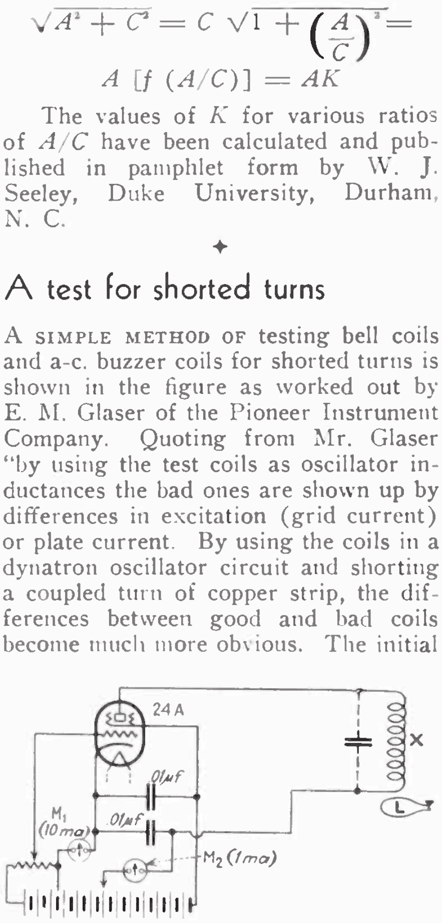
$$A \left[f\,(A/C)\right] = AK$$

The values of K for various ratios of A/C have been calculated and published in pamphlet form by W. J. Seeley, Duke University, Durham, N. C.

◆

A test for shorted turns

A simple method of testing bell coils and a-c. buzzer coils for shorted turns is shown in the figure as worked out by E. M. Glaser of the Pioneer Instrument Company. Quoting from Mr. Glaser "by using the test coils as oscillator inductances the bad ones are shown up by differences in excitation (grid current) or plate current. By using the coils in a dynatron oscillator circuit and shorting a coupled turn of copper strip, the differences between good and bad coils become much more obvious. The initial reading of the plate milliammeter would classify the coil while the change in reading would be proportional to its figure of merit.



In this shorted turn tester, X is the coil under test; L is a single turn of heavy copper; M_1 is for initial setting to compensate for changes in voltages and M_2 is calibrated for test purposes.

"These particular coils were of high impedance designed to resonate at 60 cycles with a 0.02 μf condenser. They had been tested previously by resistance method only which had led to a high percentage of later rejects for shorted turns. By the method described the number of rejects dropped to zero." Power transformers, field coils, etc., could undoubtedly be tested in this manner.

A Study of Litz wire coils—Part II

[*Editor's Note—The first part of this survey of Litz wire coils by David Grimes and W. S. Barden appeared in the November issue of* Electronics. *This part takes up the study of typical coils of 2 mh for operation at 456 kc.*]

The coils under consideration have identical inside and outside diameters, and are made of 5/40, 7/40 and 10/40 wire. Hence the 5/40 coil is the thinnest and the 10/40 is the thickest. But Q is greatest for the 5/40 coil, and least for the 10/40 coil. Now this does not mean that 5/40 is better than 7/40, and that 7/40 is beter than 10/40. It does mean that the true merit of 10/40 over 5/40 cannot be realized by simply increasing the thickness of the No. 10 coil to make room for the larger 10/40 wire—which is further evidence that Litz wire standardization must regard physical size of coil as one of the premises.

Compared No. 6 (having 5/38) with No. 5 having (7/41). Physically, these two coils are nearly alike in size. 5/38 results in Q = only 48, whereas 7/41 yields $Q = 91$. It is evident that 7/41 is far more suitable for typical practice than is 5/38.

Comparing No. 5 (having 7/41) with No. 7 (having 10/41), the strand size is the same, the outside and inside diameters are alike, and room is made for the greater number of strands by increasing the coil thickness. Q drops from 91 to 87, but this merely means that the 10/41 wire has not been used judiciously. If that particular coil diameter be a limiting factor, 7/41 is slightly preferable to 10/41.

Compare No. 3 with No. 4. No. 3 employs 7/41 E, the E meaning that enamel* is substituted for silk as a covering on the whole wire. This wire has parallel strands, with no twists. The 7/41 E results in a slightly smaller coil than the 7/41 SS. Q is the same (= 87) for both coils. Evidently the 7/41 E is as good or slightly better than the 7/41 SS at 450 kc.

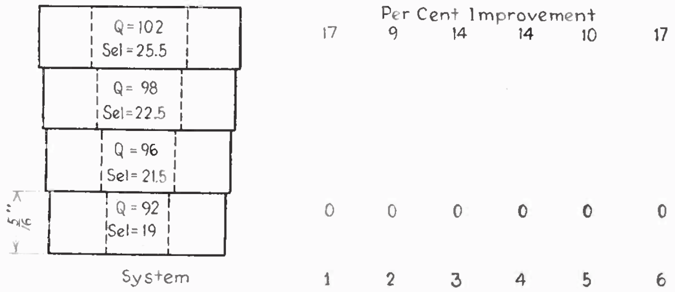


Fig. 5—Actual sizes of coils made of 10/41 Litz for use at 450 kc. Selectivity at 10 kc. off resonance is given

Note that coil 10—a thin coil of 5/40, having $Q = 90$, compares very favorably with No. 5—a somewhat thicker coil of somewhat less diameter wound with 7/41, having $Q = 91$. The indication is that 7/41 is electrically better in a typical coil than 5/40. Further data reveal the extent to which 7/41 is more worthy than 5/40. A truly rigorous result can be obtained in this instance, because 5/40 and 7/41 have very nearly the same size of wire, hence for any given physical dimensions of a coil each wire will result in the same inductance, and physical size of coil does not confuse the issue.

It is noteworthy that the best coil of the 11 in Fig. 4 is wound with 7/41 SS, and that this coil (No. 5) is a truly medium sized coil.

Interesting facts can be gleaned from a set of continuously graded coils tested at 450 kc. Consider the following data on $\frac{5}{16}$ in. coils.

		System					
		1	2	3	4	5	6
Q	Sel.	Percentage Improvement					
102	25.5	17	9	14	14	10	17
98	22.5	..	..	..	..	..	..
96	21.5			..	..		..
92	19	0	0	0	0	0	0

The coil having $Q = 102$ has an adjacent channel selectivity = 25.5 when that coil is used throughout System 1. For that coil, the gain of System 1 is 17 per cent greater than for the same system when the coil having $Q = 92$ is used throughout that system. The row of zero's indicates the coil to which better coils are compared. For System 5 the coil having $Q = 102$ is 10 per cent better than the coil having $Q = 92$, as regards gain.

Among 2-mh. coils for use at 450 kc. and wound with 10/40 SS, the least worthy coil was the thickest one having the smallest hole and the smallest outside diameter. The best coil was the thinnest having the largest outside diameter and the largest hole. Between these extremes Q ranged from 80 to 64, and adjacent channel selectivity from 13.5 to 7.5; not quite 2 to 1. For the best coil the selectivity secured was very poor compared to what can be secured at 175 kc.

On 450 kc., coils using 10/41 wire show the same characteristics—the thinnest coil being the best. The change in wire size from 40 to 41 produces a Q of 102, compared to 80. Therefore, it is easy to state that 10/41 is superior to 10/40 for 2-mh. coils worked at 450 kc.

When coils of 7/41 are compared to coils of 5/40, it is discovered that the form of the coil becomes important. Here it is not the thinnest coil that is best; it is a coil somewhat larger than the thinnest. The best 7/41 coil has Q of 96; the best 5/40 coil a Q of 90. The selectivity preference is 21.5 vs. 18.

On 260 kc. the same data hold true. Coils made from 10/41 are decidedly superior to coils of 10/40; 7/41 is slightly better than 5/40. Again form factor is of importance.

Unless coil size can be disregarded, 7/41 wire seems generally preferable to 10/41 at both 260 kc. and 450 kc.

At 175 kc., 10/41 Litz seems to be definitely out of the picture because of coil size. At 450 kc., use of 10/41 calls for thin coils of large diameter; use of 7/41 calls for thick coils of less diameter. This is of advantage in construction, because of less space in the chassis, smaller shield cans, etc.

At 260 kc. the same facts are true. If the greatest tolerable diameter is used with 10/41 coils, they do not equal in performance coils made of 7/41.

The foregoing considerations reveal that if one Litz wire were to be chosen as standard, for i-f practice, it should be 7/41 in preference to 10/41 as regards both

450 kc. and 260 kc., and, were 7/41 to be chosen in preference to any other, its performance at 175 kc. would result (generally) in a serious effect on fidelity due to side-band attenuation. Since there is a frequent desire for truly small windings, even though at a sacrifice of performance, and for i-f coils of very low cost—leading to a small amount of copper—it is important to note that 7/41 does not meet these requirements.

As an example of what can be done with poor wire, consider coil 1 (3/40 SS) a truly small coil, representing low cost on a copper basis. Its Q is 74, which renders such a coil sufficiently meritable for many cases in practice at 260 kc. as well as at 450. Due to these facts, one is inclined to reserve two, rather than one, Litz wires to cover the general i-f requirements. Suitable wires appear to be 7/41 and 3/40, although if only one were to be chosen, the following table indicates a preference for 7/41 over 3/40, although more radio receiver manufacturers reports the use of 10/41. To this extent, physical size of coil does not appear to be highly important, at least when the choice is between two large coils, rather than between a large coil and a small coil:

Litz Wire Specif.	$\frac{5}{38}$	$\frac{10}{38}$	$\frac{3}{40}$	$\frac{7}{40}$	$\frac{10}{40}$	$\frac{5}{41}$	$\frac{7}{41}$	$\frac{10}{41}$	$\frac{3}{42}$
Number of Mnfgrs.	1	1	1	2	4	1	4	6	1

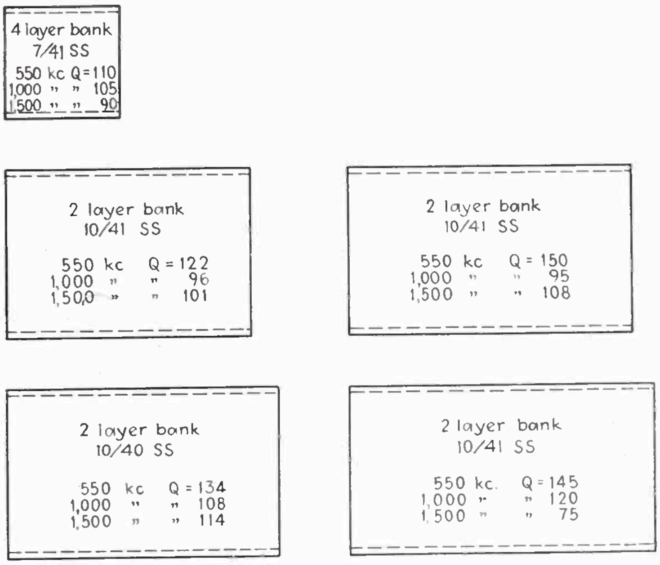


Fig. 6—Actual sizes of bank-wound coils used at broadcast frequencies

From the above data, it may be inferred that those four receiver manufacturers who use 10/40 could well add themselves to the six who use 10/41. The table shows 11 manufacturers using No. 41 wire, against 7 using No. 40. Were the 6 manufacturers who use 10/41 to add themselves to the 4 who use 7/41, they could, by proper coil design, do so without any great sacrifice of performance, and in some cases an actual improvement would be made by them in discarding 10/41 in favor of 7/41.

It appears, therefore, that if only 7/41 and 3/40 were available for i-f purposes, the Litz wire situation would be solved satisfactorily. However, there is one further influence on the choice of only three strands, and that is the effect of a broken strand. Of course strands are not supposed to break, but a broken strand in 3/40 is more serious than a broken strand in 7/41, where there are more strands. This matter is discussed below.

The assortment of r-f coils for this study was too limited to warrant any extensive consideration of figure of merit in terms of particular uses of the coils. All inductances were substantially alike, and Q is taken as the direction (but not the extent) of the relative merit. The r-f coils comprise four typical coils, and one experimental coil of very small size. These five coils are drawn (actual size) on Fig. 6, where Litz wire data and values of Q are shown. The smallest coil—four-layer bank wound with 7/41—is more meritable (from 550 kc. to 1,500 kc.) than many solid wire r-f coils having twice the diameter and twice the length of this small coil.

At 550 kc., typical solid wire r-f coils have Q's ranging from 70 to 100. For these coils, Q often varies less than plus or minus 30 per cent over the broadcast band. At 1,500 kc., the usual r-f selectivity is so poor that it is unimportant to compare Litz with solid wire at that end of the spectrum. A comparison shows that Litz wire is definitely advantageous at 550 kc., 10/41 being suitable at the low frequency end of the broadcast spectrum.

Effect of broken strands

When using fine wire, *e.g.*, No. 41, it is comforting to know that a broken strand is not of great importance, particularly when there are seven or more strands. When a break occurs, it is most likely to be found at the end of the lead where a mechanical operation prepares the wire for tinning. The following table shows the percentage loss of Q due to broken strands:

Number of broken strands	I.F. L Wire	Percentage loss			
		450 kc. 2 mh. 7/41	450 kc. 2 mh. 3/40	260 kc. 4 mh. 7/41	260 kc. 4 mh. 3/40
1	....	3	11	2	19
2	....	5	30	5	49
3	....	7	..	..	..
4	....	10	..	..	..
5	....	18	..	..	..
6	....	33	..	41	..

It is evident that the effect of broken strands is far less than proportional to the number of broken strands. One broken strand is of no practical importance. The above data apply to broken strands at the high end of a coil. Broken strands at the low end of a coil are found to have practically the same effect.

As a conclusion, it is fair to state that 3/40 is favorable when very *small* i-f coils are desired; 7/41 is desirable when i-f coils of medium size are in order; 10/41 is worthwhile only when *large* coils can be tolerated, at i.f.

At r.f., 7/41 and 10/41 are worthy at the low frequency end of the broadcast spectrum, but at 1,500 kc. no Litz wire tested in this study is to a worthwhile degree advantageous over solid wire.

The effect of a broken strand is unimportant when using 7/41 or 10/41, and not serious when using 3/40. A broken strand is not the equivalent of a removal of that strand. Despite the break, the strand still assists the process of conduction through the coil.

Considering both i.f. and r.f., 10/41, 7/41 and 3/40 appear to be three suitable Litz wires for general use in present-day receivers. The inclusion of 10/41, if not definitely logical at i.f. is desirable as regards r.f.

It is not important to make an extensive study of Litz wire at 175 kc. Only at high intermediate frequency—such as 450 kc. and at r.f. is Litz wire worthwhile.

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*Enamelitz, made by Acme Wire Company—editor's note.

electronics

McGraw-Hill Publishing Company, Inc.
330 West 42d Street
New York City

O. H. CALDWELL, *Editor*

Volume VI —DECEMBER, 1933— Number 12

Radio City—vast cathedral of electronics

WITH the National Broadcasting Company at last occupying its great studios at Radio City in New York, the dreams of the planners are being fulfilled to make Radio City a center for broadcasting, sound-picture, and musical entertainment for the nation.

And especially appropriate was the proposal of O. B. Hanson, engineer for NBC, to have the great reception-hall murals show *technical* features which underlie broadcasting. And appropriately occupying the place of honor at the center is a highly magnified electronic tube.

Without the tube, Radio City would be impossible. Using tubes in myriad numbers and forms, Radio City is a veritable modern cathedral of electronics.

Privacy on the short waves

WITH the great expansion in the number of short-wave sets in the hands of the public, a new menace to the privacy of communication on these frequencies is introduced. Radio operators are required to take an oath of secrecy. But the layman who buys a short-wave set is under no such compunction. Instead, there have been cases where listeners-in on private messages have promptly communicated their "discoveries" to newspapers.

Owners of short-wave sets should be apprised of the sanctity of the communication channels. Perhaps a tag attached to each short-wave set sold, explaining the confidential character of the frequencies about 1500 kc, would reduce disclosures, yet also increase curiosity and sales!

The radio-press war—and facsimile

THE battle between the broadcasters and the press now breaks out on a new front—the Washington press galleries.

News men of the Columbia Broadcasting System demanded admittance to these sacred seats overlooking the halls of Congress. The committee of newspaper men in charge promptly refused them. Now the radio people will appeal directly to the House and the Senate.

The issue is of interest to *Electronics* readers because it obviously portends the day of the final break. Then the broadcasters will have to get ready with facsimile for delivering their printed programs to every home—news tabloids, too—thus opening up new markets for radio sets and for accessories that "print while you sleep."

This facsimile apparatus is all worked out—it awaits only the command to "shoot!"

Static eliminators and higher power

MILLIONS of radio listeners still have their summer programs ruined by static. This vast portion of the public still fondly hopes that engineers will develop a workable static eliminator; forgetting, or not knowing, that the remedy is at hand. The ability to push nature's unwanted, uncontrollable noise into the background lies in lifting the heavy hand of the Federal Radio Commission off the natural enterprise of the broadcasters to increase station power.

It is futile to attempt to stay the discharges of lightning, or to turn aside the bombs thrown by the gods in their summer war maneuvers; but it is not difficult to improve reception for many of these millions now permitting their radios to gather dust until the annual static season is over.

The remedy has been known for years; and as long blindly neglected. The remedy is to increase the field strength of the station in the vicinity of the listener. It is as backward to limit the power of a station on a clear channel to 50 kw. as to limit a locomotive running on a clear track to its equivalent of a mere 67 horsepower.

Careful engineering needed on auto-radio initial equipment

THE plan to have all new automobiles initially equipped with factory-installed radio sets, has received some discouragement from the automobile dealers who sell the cars, and it now appears that this initial-equipment idea will not go ahead next season quite as fast as had been supposed, unless first-rate radio operation can be assured.

During the past year, trouble developed with some of the sets provided, and this worked to hold-up sales and payments in a way that has frightened some automobile dealers. After a month of use, the radio set would stop working, and then the purchaser would refuse to make his next payment until the radio was fixed. In this way, unsatisfactory radio operation has served to endanger the sale of the car itself. Unless competent engineering design of radio sets installed as initial equipment can be assured, car dealers who have suffered collection troubles prefer that the sets be left out altogether.

NEWS NOTES

Miessner piano before Radio Club, Dec. 13. A complete technical paper on the electronic piano will be presented before the Radio Club of America at Columbia University, New York City, Dec. 13, by its inventor, Benjamin F. Miessner, of Millburn, N. J.

Ford Exposition of Progress to feature electronic processes. Henry Ford is expending $300,000 on a free Exposition of Progress to be held in the great Port of Authority Building, New York City, Dec. 9 to 23. Three hundred manufacturers will co-operate, and full-scale manufacturing processes will include demonstrations of electronic-controlled welding, X-ray inspection, photocell counting and control, acoustimeter measurements, the stroboscope, and other electronic apparatus.

States would tax broadcasting. A general sales tax on broadcasting would be imposed under new bills introduced before the Kansas and Missouri state legislatures, similar to the Oklahoma law which was enacted earlier this year, and is now under attack. Five per cent of gross sales would be levied.

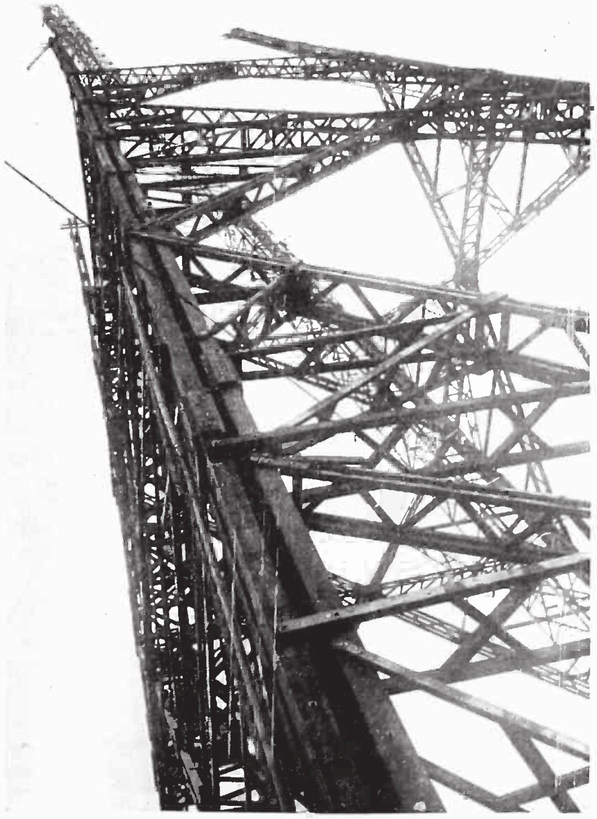
NAB broadcasting debate handbook ready. "Broadcasting in the United States," a 200-page handbook presenting arguments in support of the existing system of broadcasting, is being distributed free by the National Association of Broadcasters. Press Building, Washington, D. C.

Depreciation of broadcast stations. The Internal Revenue Bureau at Washington is studying the rate of depreciation in value of broadcasting stations, for income-tax purposes. E. M. Elkin of KDKA, and P. G. Loucks of the Broadcasters Association, are collecting data for a meeting of interested parties.

Sodium-vapor lighting in America. American sodium vapor lamps are now employed for highway lighting at Port Jervis, N. Y., and Hamilton Beach, Queens, New York City (both Westinghouse), and near Schenectady, N. Y. (General Electric), according to R. D. Mailey of the General Electric Vapor Lamp Company, who demonstrated gaseous units producing 50 lumens per watt, before the N. Y. Section, A. I. E. E., Nov. 22.

RMA Television Committee. A special committee to confer with the Federal Radio Commission on future broadcast facilities for television, facsimile, etc., comprises Walter E. Holland of Philadelphia, chairman; J. A. Chambers of Cincinnati, chairman of engineering for the National Association of Broadcasters; Ray H. Manson of Rochester, N. Y., and Dr. W. R. G. Baker of Camden, N. J.

WOODEN TOWER, 483 FT., FOR BERLIN BROADCASTER



Timber-frame towers have been used extensively in Germany. Here is construction view of the new Tegel station near Berlin, to be opened this month

REVIEW OF ELECTRONIC LITERATURE

HERE AND ABROAD

Improvements in medium voltage cathode ray tube

[M. VON ARDENNE, Ardenne Laboratory] All the electrodes with the exception of the plate are made of non-magnetic material; the plate (3000 V) is slightly magnetized so as to reduce to zero the deflection caused by the earth's magnetic field. Platinum is now being used as a support for the oxide; the heating current may vary by +5 per cent without affecting the results. Origin distortion is eliminated by a clever arrangement of the deflecting plates. The four deflecting plates go to separate binding posts arranged around the plate connection in the center of the base. The luminescent material is no longer deposited upon the glass bulb and viewed from behind, but on a separate glass surface 4x4 in. placed obliquely with respect to the axis of the tube, the figures being observed from in front or projected upon a screen. Distortion that might result is corrected by having the deflecting plates form an angle with one another and the glass container free from defects. Sufficient light, about six times more than before, is obtained with the new tubes to throw an image covering $\frac{1}{4}$ to 1 sq.m. upon a screen during lectures.—*Funkt. Monatsh. 2: 333-340. 1933.*

✦

Full voltage amplification with screen-grid tubes

[R. SEWIG AND W. KLEINSCHMIDT, Dresden, Institute of Technology] Full amplification of course requires high resistance in the plate circuit and the advantages of using the most recent types of photoelectric cells, operated near saturation, are pointed out, for instance cesium vacuum cells which give saturation at 30 volts and 0.1 to 1 ma. when exposed to the light of a 40 watt lamp and represent a resistance of about 100 meg. The response is practically independent of the frequency when the capacity of the screen grid tube, cell and leads are kept below 10μ f.—*Zeits. techn. Physik* 14: 388-390. 1933.

✦

Push-pull grid-controlled inverter

[I. RUNGE AND H. BECKENBACH, Osram Laboratory] The mathematical discussion of the symmetrical circuit for changing d.c. into a.c. by means of grid-controlled discharge tubes (Fig. 1, *Electronics*, April, 1931, p. 581) shows that when the ohmic load is small, the condenser C can be so chosen that the fundamental frequency predominates; this is the case when the reciprocal of the inductance of the choke coil L equals the sum of four times the admittance of the condenser plus the admittance of half the transformer primary, that is $4\,p\,c - 1/2pT - 1/pL$ equals zero ($p = 6.28$ times frequency). For instance, when the load is equal to $2.5/pL$, the first overtone amounts to not more than 6 per cent of the amplitude of the fundamental. To approach sine curves when loads are heavy, large condensers must be used which tend to give triangular waves as soon as the load decreases and produce very high voltage. By making the condenser C progressively smaller, successive overtones are obtained in great strength. Oscillograms confirm the conclusions drawn.—*Zeits. Techn. Physik* 14: 377-385. 1933.

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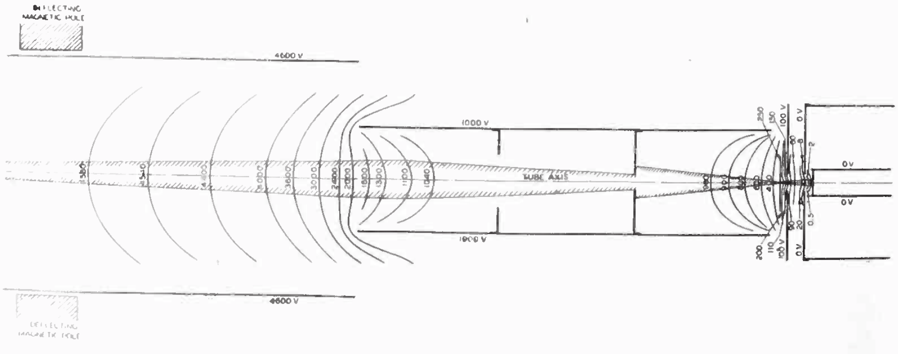
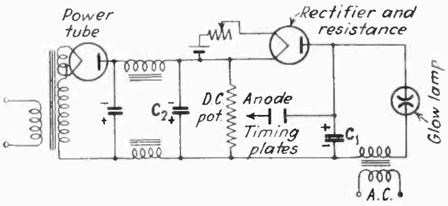
ELECTRON PATH IN CATHODE RAY TUBE



Typical electron beam outline and equipotential line plot showing focussing effect of voltages—see page 332 this issue

Uses for the cathode-ray tube

[J. KAMMERLOHER] Synchronization is obtained by means of a condenser C charged gradually through a diode according to a logarithmic law, while the a-c potential to be studied charges at each half-wave a second condenser over a transformer and rectifier so connected that the a-c potential determines the moment when the discharge passes through a glow lamp at each third or fourth, etc., alternation and discharges the condenser giving the time axis. One of the most important uses of this simple circuit is the study of tube characteristics at various loads by applying a-c to the properly biased grid. The grid is connected to the horizontal pair of deflecting plates and produces the horizontal or voltage axis; a pair of coils introduced into the plate circuit gives the vertical deflection so that plate current versus grid voltage curves are traced by the beam. The properties of low or high pass filters for a.f. can be studied by using the shaft of the rotor for carrying the photographic paper.—*El. Techn. Zeits.* 54: 1019-1022. 1933.



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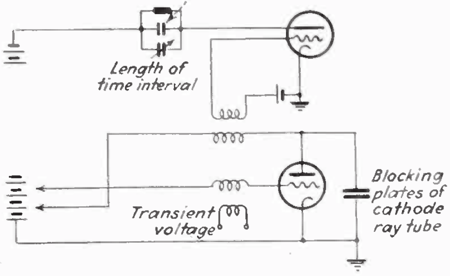
Testing of receivers by means of resonance curves

[GUENTHER ULBRICHT, Hannover Institute of Technology] The method described by the RCA Victor Co. (Pr. I.R.E. 20:1580 — 1932) and also used by one firm in Germany is rather expensive. A simpler test is possible with the cathode ray tube replacing the oscillograph, vacuum tube voltmeter, screen and rotating mirror. The 60 cycle supply voltage is sufficiently constant to give the time axis when applied to one pair of deflecting plates the rotor plates of the oscillator are given a sinusoidal shape (figure of eight), while the stator plates are quarter circles, and the rotor is set in motion by a synchronous motor making 1,800 r.p.m. As the frequency varies as a result of this motion, the return points of the cathode ray beam trace a continuous curve, the resonance curve, of the circuit.—*Hochfr. Techn. El. Ak.* 42: 135-137. 1933.

Cathode ray time axis and blocking circuits

[W. Fuchs and H. Kroemer, Aachen Institute of Technology] When transient voltage changes taking place at random are to be recorded, it is necessary to apply them to one pair of deflecting plates, to use a second pair for giving the path free to the ray within perhaps not more than one ten millionth sec. after the sudden change has set in and to produce a linear time axis with the aid of a third pair of plates. It is possible to perform the latter two tasks with a single source of voltage when a dynatron circuit is used, cathode and anode being connected to the blocking plates and the plate potential of the vacuum table so chosen that no current flows. The appearance of the transient is made to shift the grid voltage so that the plates discharge across the tube and a wave front advances through the transformer or primary, causing the charging up of the time sweep plates. As conditions return to normal, the tube current slides along the falling characteristic and stops, and the timing plates discharge across a resistance. The device allows the study of the wave shape of broadcast waves.—*Archiv. El. Techn. 27*: 606-608. 1933.

Resistance time-axis plates of cathode ray tube



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Television progress in Germany

[Georg Kette] The organizations exhibiting their receivers at the tenth annual radio show in Berlin-Witzleben were (when 90 means 90 lines, 10,800 elements 25 pictures per sec., and 180 means 180 lines, 40,000 elements, 25 pictures per sec., or frequency bands of 125,000 cycle resp. 500,000 cycles per sec.): German General Post Office: two cathode ray receivers (90 and 180); Fernsch A.G.: mirror screw (90/600/25), cathode ray (180); Telefunken: cathode ray (180); Tekade: mirror screw with glow lamp (90) and sulphide of zinc cell Loewe Radio: cathode ray (180); Mihaly (rotating mirror throwing light beam upon stationary mirror wheel (90); Von Ardenne: cathode ray transmitter of constant intensity, but variable speed. The large number of cathode ray receivers stands out. Pictures with 90 lines are suitable for telemovies and television of single objects; 180 line pictures seem to permit the

transmission of actual scenes, but all the tests made to date depend on the transmission of the picture over wires. The intermediate-film sender has been developed further so as to give a new emulsion and exposure to the film after it has been projected.—*Ferns Tonfilm* 4: 53-61. 1933.

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BOOK REVIEW

Electron tubes and their application —

By John H. Morecraft. Published by John Wiley & Sons, New York, 1933. (458 pages, 537 figures. Price $4.50)

As suggested by the title the book deals with the various types of electric discharge tubes, not vacuum tubes alone, which have proved to be useful in engineering. The first sixty pages show under what conditions electrons are caused to leave the inside of metallic bodies. Numerical relations are used wherever possible in order to present a concrete picture of the physical processes, and in many cases striking comparisons result which are easily imprinted upon the memory (for instance, the output of photo electrons, pp. 41-42, and later the internal resistance of vacuum tubes, p. 72). In some cases, however, the imagination has wandered too far, and the picture has become distorted; for instance, the velocity of the electrons does not vary with the temperature, as described (pp. 8, 16 and 21), but is practically the same a few hundred miles per sec., at room temperature and at white heat, a fact proven by the value of the specific heat and by the work done at the Bell Laboratories and elsewhere.

Having laid a firm basis two and three electrode tubes are discussed. Much stress is laid on the conditions under which the triode may have a negative input resistance.

Short chapters of about twenty pages each describe hot cathode gas-filled tubes (including the cathode ray tube), photoelectric tubes (where the probable nature of Photronic cells is indicated), and special electronic devices. The actual uses to which electronic tubes are put in various fields are then mentioned. An extended discussion follows (pp. 237-408), dealing with the part which the triode plays as amplifier, oscillator, modulator and detector. The direct current, or as the author says, continuous current amplifier is given a little less than two pages. The book concludes with short sections on the uses of gas-filled three-electrode tubes, the electron tube as an electric motor and special use of electron devices.

The book ought to fulfil quite well the author's purpose to serve as a general course on electron tubes for engineering students of all branches. A point also worth mentioning is that among the 90 references to articles having appeared in various periodicals, there are 40 references to the *Proc. I.R.E.* from 1918 on, 15 to the A.I.E.E. for about the same length of time, 10 to the *Physical Review*, and no less than 20 to *Electronics* for the short span from April, 1930, to August, 1932.

◆ ◆ ◆

DIAL YOUR PROGRAM!

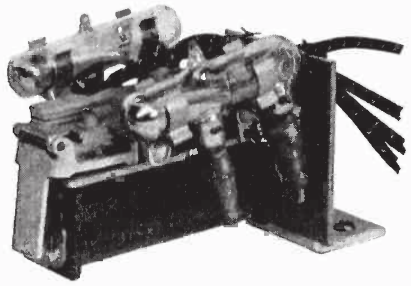
O. B. Hanson, NBC manager of engineering, (left) explains to R. C. Patterson, Jr., executive vice-president, the method by which any studio or station program can be dialed

+ NEW PRODUCTS

THE MANUFACTURERS OFFER

Mercury-contact relay

A NEW MERCURY-CONTACT RELAY for a-c operation has recently been perfected by the American Automatic Sales Company, 1033 W. Vanburen Street, Chicago, which will handle comparatively heavy currents with complete satisfaction. This relay is quick-acting, and can be equipped with either one or two mercury contacts. It can be repeatedly operated and released and will still produce "clean" makes and breaks. The same contact can be used for either making or breaking a circuit, depending upon the setting of the support. The relay is similar to the company's d-c relays, and can be supplied either with an angle bracket or on a bakelite base with cover. It is designed to operate on 110 volts, 60 cycles, and has contact ratings for d-c or a-c non-inductive loads as follows: 25 amperes at 80 volts, 20 amperes at 120 volts and 10 amperes at 240 volts.—*Electronics.*



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Lumotrons General Scientific Corporation product

LUMOTRON PHOTO-ELECTRIC CELLS, which were described in October *Electronics,* page 290, are produced and distributed by the General Scientific Corporation, 4829 South Kedzie Ave., Chicago, successors to QRS Neon, Inc. This company also makes grid-glow tubes, television lamps, neon tubing and electrodes, animators, vacuum gauges, and optical products. Through an error in the above-mentioned item, the name of the General Scientific Corporation was incorrectly stated.

A Chicago company of somewhat similar name, also known to *Electronics* readers, is the Central Scientific Company, 460 East Ohio St., Chicago, which has been established since 1889 and which manufactures and deals in scientific apparatus, laboratory instruments, reagent chemicals and supplies. The new Cenco-Browne high-voltage electrostatic generator, built by the Central Scientific Company, which produces emfs up to 750,000 volts under all conditions of temperature and humidity, was described in *Electronics,* January, 1933, page 27. Other Central Scientific Company products which have been described in *Electronics* are high-vacuum pumps, high-frequency oscillators, rheostats, and the Zeleny electroscope. — *Electronics.*

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Wire for radio tubes

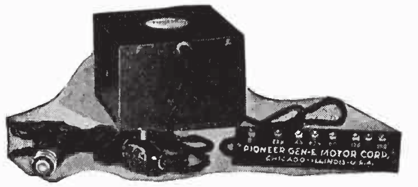
KEMET LABORATORIES COMPANY, INC., 30 East 42nd St., New York City, a unit of Union Carbide and Carbon Corporation, has developed and is manufacturing and selling a new wire for use in radio tubes, which consists of an alloy of molybdenum, iron and nickel (approximately 20 per cent Mo, 20 per cent Fe and the balance largely nickel). It has good strength and ductility at ordinary temperature (tensile strength about 140,000 lb. per sq.in., and elongation about 28-30 per cent), has good winding qualities and is characterized by exceptionally high strength and stiffness at elevated temperatures. The tensile strength at 800 deg. C. (1,472 deg. F.) is approximately 60,000 lb. per sq.in. and the stiffness is comparable to that of pure molybdenum.—*Electronics.*

◆

32-180-volt generator

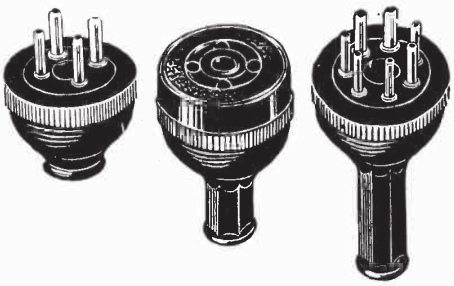
THE PIONEER GEN-E-MOTOR CORPORATION of 1160 Chatham Court, Chicago, Ill., has just announced a new genemotor which provides 180 volts, d.c. from 32-volt input.

This new addition supplies "B" power from 32-volt farm light systems. Two models are available. One is complete with filter and intermediate voltage taps, which may be connected direct to any battery-operated receiver and thereby eliminate all B batteries. The other model is supplied stripped of filter and intermediate voltage taps to meet the needs of set manufacturers who are producing radio receivers that operate direct from 32 volt farm light circuits. —*Electronics.*



Rubber-capped plugs

DESIGNERS OF RADIO and associated apparatus of a more or less portable nature have long been in need of connector plugs that would stand up under rough use. For this purpose the Eby line of heavy duty rubber-capped plugs, when used with the newer rubber-covered cables, makes a combination which will stand the most severe usage. These plugs have been adopted by manufacturers for portable apparatus such as public-address and sound recording equipment, and are also being widely used for Automobile Radio power supply connection.



They are intended for service where moderate current carrying capacity is desired, and where voltages are not in excess of 500 volts. It is to be noted that the insulation resistance between conductors or contacts is extremely high because of the excellent insulating material used in the construction.

These plugs are supplied for four, five, six or seven-prong conductor cables in either male or female types with a selection of various styles and sizes of black rubber caps. H. H. Eby Manufacturing Company, 21st St. and Hunting Park Ave,, Philadelphia, Pa. — *Electronics.*

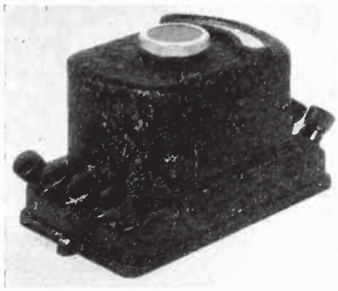
◆

Multiple-coil air-core reactors

A MULTIPLE-COIL air-core reactor for laboratories and test-rooms has been developed by the Metropolitan Device Corporation, 1250 Atlantic Avenue, Brooklyn, N. Y. The coils may be connected single, in series, in parallel, or in series-parallel relation. The unit is constructed entirely of non-magnetic materials, and the coils are arranged in a relation of negligible mutual inductance. By inserting iron cores into the coil centers, the coil reactances are readily changed, or the circuit waveshaves may be modified. The reactors may be used on single or polyphase circuits up to 440 volts.—*Electronics.*

High-sensitivity relay

A NEW AND HIGHLY SENSITIVE relay has been announced by Ashcraft Automatic Control Company, Hollywood, Calif. This relay has a low internal resistance (100 ohms) and is sufficiently sensitive to close on the output of caesium and photronic type cells. An input light intensity of ½ footcandle will cause the relay to close, according to the maker. Contacts carry 3 amperes at 110 volts a.c. It is said to be immune from trouble due to vibration. Relay may be set for closing its contacts for a current variation of 1 microampere to 200 microamperes. Price $35.—*Electronics.*



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Electrical door-opening mechanism

AN ELECTRICAL DEVICE providing improved automatic door-opening service for garage doors has been announced by the Barber-Coleman Company, Rockford, Ill. It consists of a magnetic latch which holds the door closed until it is released by a control switch, whereupon tension in balance springs of the door pulls the latter open.—*Electronics.*

◆

Sensitive relay

PRODUCTS DEVELOPMENT COMPANY, 933 West Main St., Louisville, Ky., is marketing the micro-relay, designed by W. Van Benschoten. In the plate circuit of an electronic tube is a normally-closed relay, which is held open by the residual value of the plate current with an unbiased grid. The controlling contacts are so wired that when they come in contact a negative bias is placed on the grid, which immediately causes the relay to close, through the fall of the plate current. This action occurs with contact resistances up to 20 megohms.

The micro-relay is of value in connection with mercury thermometers, pyrometer control, photo-cells, limit-switch applications, display advertising, etc. Price of micro-relay, a.c. and d.c. single and double poles, $30 to $40.—*Electronics.*

Portable oscillator

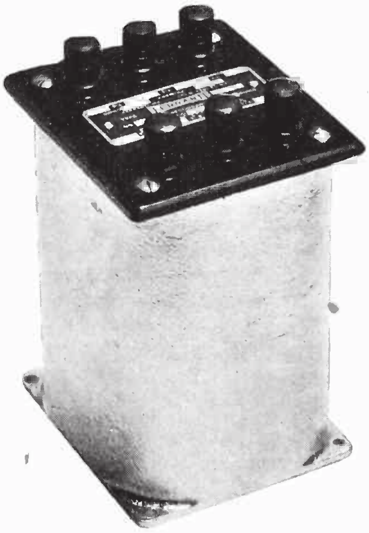
THE NEW SERIES 31 portable DayraD test oscillator provides all frequencies from 105 to 1,650 kilocycles. Accuracy is assured by means of a transparent dial with a hair line. The instrument is thoroughly shielded and by-passed. The attenuator, separately shielded, offers signals of varying intensity necessary for the alignment and neutralization of all types of radio sets. This unit is described in Bulletin 37. The Radio Products Company, Dayton, Ohio. —*Electronics.*

◆

Transformers and chokes

FERRANTI, INC., 130 West 42d St., New York City, has just published a new 1934 catalog covering its line of transformers and chokes for use in the communication field.

During the past year more than one hundred new tubes have been released on the market, and this catalog is an attempt to cover up-to-date precision transformers for use with the more commonly used types of these new vacuum tubes.



An instance of unusual conditions which Ferranti can meet is typified by a transformer specification ± 1 db. from 30 to 25,000 cycles.

The Ferranti Company has extended its New York laboratory and engineering facilities and is now specializing in the production of quality iron-ore products.—*Electronics.*

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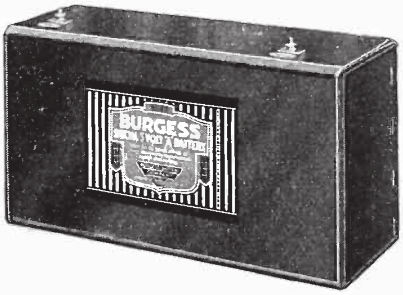
Mercury-arc switches

"NO-ARC" MERCURY TUBE SWITCHES made in 1, 2, 3 and 4 poles, each pole consisting of a mercury-tube switch with ratings of 30 amp., 125 volts; 20 amp., 250 volts, either a.c. or d.c., for controlling inductive loads, such as multiple street-lighting circuits, have been announced by the Hart Manufacturing Company, Hartford, Conn. —*Electronics.*

Battery for 2-volt tubes

THE BURGESS BATTERY COMPANY, Freeport, Ill., announces its No. 1040 A battery especially designed for 2-volt tube radio receivers. This new A pack embodies a close-pak construction which makes it light, portable, and economical.



The unit will give 400 hours service at a cost of less than one cent per hour. Weight, 15 lbs.; size 12 in. by 4 in. approximately. The unit is 100 per cent dry, hermetically sealed, and requires no servicing with water or chemicals. List price, $3.20.—*Electronics.*

◆

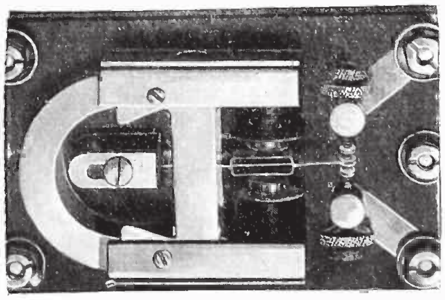
Laminated bakelite

INSTRUCTIONS FOR MACHINING laminated bakelite, in chart form for ready reference, are presented by the Synthane Corporation, Oaks, Pa. The various processes described for most satisfactory handling include circular sawing, band sawing, threading, milling, gear-cutting, drilling, punching, turning and boring, and the use of automatic screw machines. Details of maximum cutting speeds are given.—*Electronics.*

◆

Polarized relay

THE DUNCO POLARIZED RELAY, for operation where the direct current in the coils must be kept as low as possible, and where reversal of current reverses contacts, while deenergization of coils opens the contacts, has been produced by Struthers Dunn, Inc., 148 North Juniper St., Phila., Pa.



The strength of the permanent magnet used with the push-pull coils, is adjustable by means of a shunt. The contacts break 2 amp. a.c. 110 volts, or one-quarter ampere direct current, 115 volts, non-inductive load. Relays can be furnished with total coil resistance up to 6,000 ohms, and the operating power required is as low as 0.01 watt, direct current. Price $21.—*Electronics.*

U. S. PATENTS

IN THE FIELD OF ELECTRONICS

Radio Circuits

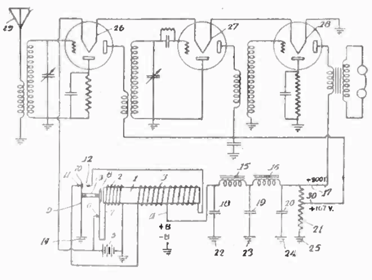
Beam receiver. Several spaced antennas; method for heterodyning the waves collected upon these antennas to a lower intermediate frequency, frequency multiplying the intermediate frequency energy to the frequency of the received wave, regeneratively amplifying said frequency multiplied energy and combining the frequency multiplied energy whereby the directive characteristic of the antenna is improved. J. Plebanski, assigned to R.C.A. No. 1,935,375.

Antenna system. A pair of closely spaced feeder members connected to a single receiver extending in the direction of desired communication and several antennas simultaneously coupled thereto. H. O. Peterson, R.C.A. No. 1,935,373.

Volume control. For circuits utilizing screen grid tubes, method of reducing volume by reducing the positive screen grid biasing potential of one or more of the tubes and simultaneously lessening the signal energy transferred. J. M. Miller, assigned to Atwater Kent Mfg. Co. No. 1,934,940.

Communication system. Method of radio communication which includes generating a rotary-polarized wave, receiving wave to produce a polyphase oscillating current, mixing current with a second polyphase current, and detecting the slip current thereby. R. M. Heintz, assigned to Heintz & Kaufman, Ltd. No. 1,934,924.

Voltage converter. Method of operating a receiver from a source of direct current by means of a vibrator, transformer and rectifier filter. R. J. Keogh, assigned to Utah Radio Products Co. No. 1,935,569. Also No. 1,935,568.



Automatic volume control. For use in a receiver having an r.f. amplifier, a detector, and an oscillator. The a.v.c. tube is connected to the anode circuit of the detector and a two element rectifier for impressing the voltage variations on the input electrode to control the gain. Wolfgang Kautter, assigned to Siemens & Halske. No. 1,931,660.

Volume control. Method for reducing the potential with respect to ground on the cathode of an amplifier as the volume of the selected incoming signal increases. L. M. Perkins assigned to Delco-Remy Corp. Filed Aug. 15, 1929. No. 1,933,148.

Direction finder. Combination of a fixed beacon transmitting station, and a mobile receiving station, the beacon comprising means for transmitting waves whose instantaneous phase varies uniformly along the arc of a circle centering in the beacon and the receiver comprising phase discriminating means. P. H. Evans and J. W. Greig, assigned to B.T.L., Inc. No. 1,933,248.

Dual-band receiver. A t.r.f. coupling system to operate over two frequency bands, comprising a single primary winding and two secondary windings coupled thereto. The primary is shunted by a capacity of such value that the circuit is capacitively reactive to one of the frequency bands; a capacity coupling between the circuits including primary and secondary, and a switch to short-circuit one of the secondary windings to change the frequency bands. H. A. Wheeler, assigned to Hazeltine Corp. No. 1,933,402.

Short wave system. A beam transmitter adapted to mark out a course by emitting characteristic signals along each outer boundary comprising an oscillation generating system a directive radiating system, etc. Werner Ludenia, Berlin, assigned to Telefunken. No 1,934,078.

Short wave generator. A high frequency generator of polyphase currents comprising at least three multiple discharge devices, etc. W. J. Brown, assigned to Associated Electrical Industries, Ltd., No. 1,934,523.

Single control system. Method of simultaneously changing the resonant points of several circuits in a heterodyne type receiver. Arthur G. D. West, Beckenham, England. No. 1,933,778.

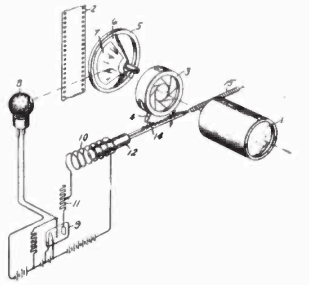
Diversity reception. Method including collecting radiated energy of the same wave length at several geographically spaced points, separately amplifying and controlling each of these energies and combining them properly. Fritz Schröter and Wilhelm Runge, assigned to Telefunken. No. 1,934,211.

Electron Tube Applications

Train control system. Two opposed sources of power, the voltage of one of which is determined by the speed of the train and the supplied voltage of the other of which is controlled by traffic conditions. A. G. Williamson, assigned to Union Switch & Signal Co. No. 1,933,780.

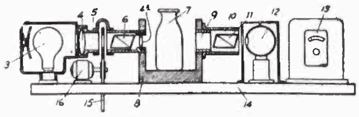
Photographic apparatus. Method of controlling the printing time by means of a light sensitive cell. C. M. Tuttle and D. A. Young, assigned to Eastman Kodak Co. No. 1,933,831.

Automatic exposure system. Method using a light sensitive cell for controlling the exposure of a film by automatically varying the intensity of the light by means of a diaphragm. G. Camilli, assigned to G. E. Co. No. 1,934,484.



D-C A-C system. A vibrator-synchronous rectifier system for supplying high voltage d-c from a source of low voltage d-c. R. J. Rockwell, assigned to Crosley Radio Corp. No. 18,971.

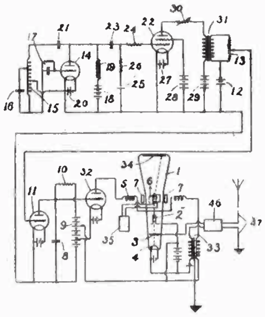
Translucent testers. A device for determining the polarization effect of strains in a translucent substance such as a glass object by means of a source of polarized light, and photoelectric cell. R. S. Glasgow and A. L. d'Adrian, St. Louis, Mo. No. 1,934,187.



Water softener. Method of operating and actuating water softeners by means of photoelectric cells, etc. O. R. Sweeney and T. B. Clark, assigned to the Permutit Co. No. 1,931,968.

Current measuring device. Method of measuring a circuit carrying both alternating and direct current. P. F. Jackson, assigned to the Radio Products Co. No. 1,931,763.

Deflection system. Method for deflecting electron passage in a cathode ray tube, comprising saw-tooth voltage generating means, etc. T. Nakajima and K. Takayanagi, Japan. No. 1,933,219.



Translating circuit. Combination of an intermittently conductive grid controlled tube, a source of a-c for the grid circuit, a self-saturating transformer for converting a-c into a peaked wave form and rectifiers across the saturated transformer to bypass the negative half cycles of the peaked grid circuit potential. August Schmidt, Jr., assigned to G. E. Co. No. 1,935,460. See also No. 1,935,464 to C. H. Willis, assigned to G. E. Co. on a similar circuit.

Velocity measuring apparatus. Method of measuring the velocity of a fluid by a movable member whose vibrations are at a frequency substantially directly proportional to the velocity of the fluid and an indicating device comprising a rectifier meter. W. B. Heinz, assigned to G. E. Co. No. 1,935,445.

Trouble detector. A fault responsive apparatus including amplifying circuits for polyphase a-c system. Jean Fallou, assigned to G. E. Co. No. 1,935,439.

Inverter. Combination of a d-c supply circuit and a-c load circuit and a self-excited thermionic tube inverter. B. D. Bedford, assigned to G. E. Co. No. 1,935,431.

Welding system. A method of using an arc discharge device in a welding circuit for control. D. C. Prince, assigned to G. E. Co. No. 1,935,413.

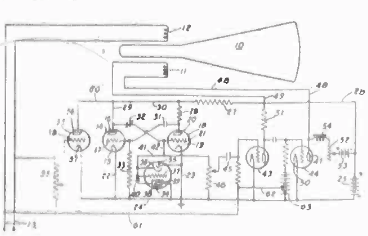
Electrical musical instrument. Combination of a series of resilient vibrators vibrating at different periods, electro-mechanical means including a moving part connected to the vibrators, method for amplifying the impulses generated in this electro-mechanical means. V. H. Severy, assigned to Central Commercial Co. No. 1,935,215.

Electrical sterilizing apparatus. Method for sterilizing fluent material comprising a dielectric closed container and means for passing the material through it. K. E. Golden, assigned to Ray-dio-Ray Corp. No. 1,934,704.

Amplification, Generation, Etc.

Television system. A two-way television system comprising scanning systems, receivers at each end, multiple light reflecting means, etc. H. E. Ives, assigned to B.T.L., Inc., filed Oct. 1, 1926. No. 1,932,253.

Oscilloscope. Cathode ray apparatus comprising a multi-vibrator having unsymmetrical plate circuits and grid-leak resistors, one of said resistors comprising a vacuum tube operated with constant plate current, and a timing wave connected across the other resistor. W. O. Osbon, assigned to W. E. & M. Co., application dated June 10, 1932. No. 1,934,322.



Facsimile system. Method of radiating heat from a point outside of the surfaces to be transmitted, collecting the heat rays and projecting the rays to a color surface. E. Wildhaber. No. 1,934,753.

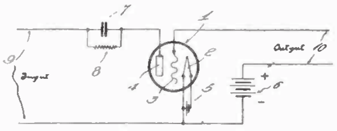
Modulating system. Oscillations produced by a neon tube are modulated by a light sensitive cell. H. J. McCreary, assigned to Associated Electric Laboratories, Inc. No. 1,934,726.

Detector circuit. Method involving an auxiliary tube for securing a detector output circuit which rises rapidly at lower inputs and flattens off at higher inputs. R. H. Galt, assigned to B.T.L., Inc. No. 1,935,316.

Oscillation system. A fundamental wave is supplied to the grid of a tube of a frequency which is an aliquot fraction of the desired frequency and of predetermined amplitude. Negative grid biasing voltage of such value that the constant component of the resulting control voltage is smaller than the amplitude is supplied to the grid. A tuned circuit in the output and coupled to the grid applies a compensating voltage to eliminate the action of the anode potential on the control voltage. Mauritz Vos, assigned to Ericsson. No. 1,934,574.

Modulation system. Patent granted to August Hund, assigned to Wired Radio. 36 Claims. Applied for May 17, 1926. Involves a modulating piezo electric crystal circuit. No. 1,933,735.

Rectifier circuit. Method of converting an input potential to a lower potential by connecting the potential to the plate-cathode circuit of the tube and taking out the desired potential from the grid-cathode. F. E. Terman, assigned to Wired Radio. No. 1,933,773.



Integrating circuit. Electrical impulses varying in intensity are converted into impulses that are of substantially constant intensity, but which vary in duration by means of a triode, a glow discharge tube and an output relay. M. P. Hanson, assigned to Wired Radio. No. 1,933,976.

Frequency divider. Method of obtaining sub-multiple of an impressed frequency. W. F. Curtis, Washington, D. C. No. 1,933,970.

Crystal control circuit. Patent No. 1,933,967, to Albert Crosley, assigned to Wired Radio. Application filed Aug. 19, 1927.

Frequency analyzer. Method using several mechanical resonators having compliance couplings between to produce a beat frequency. T. M. Berry and M. S. Mead, Jr., assigned to G. E. Co. No. 1,933,306.

Super-regenerative circuit. Use of a glow tube for obtaining super-regenerative action. Rudolf Urtel, assigned to Telefunken. No. 1,931,950.

Voltage regulator. Method using a capacitive reactance and being saturated for inductive reactance to maintain voltage constant. H. A. W. Klinkhamer, assigned to R.C.A. No. 1,932,667.

Electron coupled oscillator. Use of a four element tube. The inner electrodes, namely, the cathode, the control grid and an inner anode are included in an oscillator circuit and an outer anode is used as an output electrode. J. B. Dow, Alexandria, Va. Application Feb. 10, 1931. No. 1,931,530.

Volume control. Method of controlling the transmission-frequency characteristics of an inter-stage system. S. D. Lavoie, assigned to R.C.A. No. 1,931,664.

Frequency multiplier. The grid of the tube is biased to the cut-off and when excited a means is provided for changing the bias in proportion to the change in the amplitude of the output current. E. Kramar and Hans Rochow, assigned to Lorenz. No. 1,931,870.

Patent Suits

1,879,863, H. A. Wheeler, Volume control; 1,755,114, L. A. Hazeltine, Unicontrol signaling system; 1,755,115, same, Variable condenser, filed Sept. 14, 1933, D. C., S. D. N. Y., Doc. E 76/293, Hazeltine Corp. v. York Automotive Distributing Co., Inc.

1,901,735, A Crossley, Piezo electric crystal system; 1,627,958, same, Radio frequency choke coil system; 1,831,151, G. P. Walker, Temperature control system for frequency determining elements; 1,822,928, A. Hund, Piezo electric plate; 1,649,828, same, Method of preparing piezo electric plates; 1,683,093, Mirick & Crossley, Piezo electric crystal apparatus, filed Sept. 26, 1933, D. C., S. D. Ohio, W. Div., Doc. E 870, Wired Radio, Inc., v. Radio Station WFBE, Inc.

1,710,073, 1,714,191, 1,891,207, S. Ruben, Electrical condenser, filed Aug. 15, 1933, D. C., S. D. N. Y., Doc. E 76/231, Ruben Condenser Co. et al. v. Polymet Mfg. Co., Inc., et al

1,455,141, Lowell & Dunmore, Radio receiving apparatus; 1,606,212, same, Power amplifier; 1,635,117, F. W. Dunmore, Signal-receiving system, filed Aug. 17, 1933, D. C. Md., Doc. E 2193, P. D. Lowell et al. v. A. G. Triplett et al.

1,855,168, C. L. Farrand, Loud-speaker, filed Nov. 12, 1932, D. C., N. D. Ill., E. Div., Doc. 12536, Utah Radio Products Co. et al. v. Triangle Electric Co.

1,789,949, A. Georgiev, Electrolytic cell; 1,815,768, same, Electrolyte, filed Aug. 23, 1933, D. C., E. D. N. Y., Doc. E 7048, Aerovox Corp. v. McArnold Radio Corp.

1,195,632, W. C. White, Circuit connections of electron discharge apparatus; 1,239,852, F. K. Vreeland, Receiver of electrical impulses; 1,544,081, same, Transmitting intelligence by radiant energy; 1,251,377, A. W. Hull, Method of and means for obtaining constant direct current potentials; 1,297,188, I. Langmuir, System for amplifying variable currents; 1,573,374, P. A. Chamberlain, Radio condenser; 1,728,879, Rice & Kellogg, Amplifying system; 1,820,809, E. W. Kellogg, Electrical system, filed Aug. 30, 1933, D. C., S. D. N. Y., Doc. E 76/266, Radio Corp. of America et al. v. H. Antin et al. (A. H. Grebe & Co.).

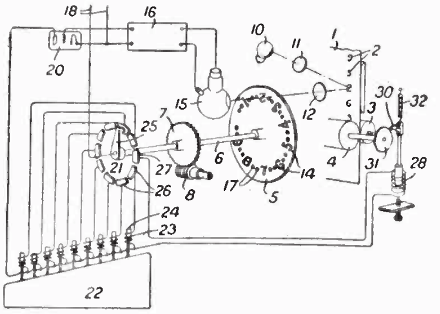
1,231,764, F. Lowenstein, Telephone relay; 1,618,017; same, Wireless telegraph apparatus; 1,403,475, H. D. Arnold, Vacuum tube circuit; 1,465,332, same, Vacuum tube amplifier; 1,432,022, R. A. Heising, Circuit connection of electron discharge; 1,507,016, L. de Forest, Radio-signaling system; 1,507,017, same, Wireless telegraph and telephone system; 1,811,095, H. J. Round, Thermionic amplifier and detector; Re. 18,579, Ballantine & Hull, Demodulator and method of demodulation, filed Aug. 30, 1933, D. C., S. D. N. Y., Doc. E 76/265, Radio Corp. of America v. H. Antin et al. (A. H. Grebe & Co.).

BRITISH PATENTS

IN THE FIELD OF ELECTRONICS

Electron Tube Application

Statistical machine. Cards bearing numbers are placed so that one of the first characters of the number is imaged by means of a photo-electric device, etc., to actuate registering or recording mechanism. P. W. Handel, assigned to British Thomson-Houston Co., Ltd. No. 396,504.



Automatic steering apparatus. Method of steering aircraft or other moving craft automatically in accordance with a course determined by a magnetic compass and also in accordance with signals received from a radio beacon when the craft drifts from the course. An earth inductor compass is used and gyroscopic means are provided for correcting for the vertical component of the earth's magnetic field due to tilting of the compass platform during a turn. E. F. W. Alexanderson, British Thomson-Houston Co. No. 396,547.

Remote control. A relay adapted to close a local circuit to sound an alarm, or to start up a machine or to control the steering gear of a moving craft in response to a wireless signal, comprises two moving systems mounted in the field of a magnet and so arranged that current supplied to a terminal flows first through a coil to a brush and then to another brush and through a second coil in the reverse direction. Any change in the strength of the current fed to the terminals moves the two coils in opposite directions, closes the contacts and energizes a buzzer. C. L. P. Dean and C. W. H. Beglie, Brighton. No. 396,753.

Facsimile and picture transmission. Transmission is keyed or intermittently interrupted in accordance with the picture signals to compensate at the receiver for variations in the general intensity of the signals by fading or interference. The degree of amplification of the receiver is automatically adjusted at predetermined time intervals in accordance with the intensity of the incoming signals. Lorenz. No. 396,811.

Course indicator. Method of maintaining an aircraft or other moving craft on a direct course toward its destination despite any tendency to drift by steering it automatically in accordance with a magnetic or gyroscopic compass associated with a directive antenna. British Thomson-Houston Co. No. 393,436.

Railway communication. Method of communicating to or between moving vehicles or between different parts of a train on a track by means of a high frequency transmission line alongside the track. British Thomson-Houston Co. No. 393,440.

Arc lamp control. Apparatus for returning a moving source of radiation such as an electrode to its correct position consisting of two thermostatic devices. Carl Zeiss. No. 393,530.

Apparatus control. Thermally uniting or dividing metal sheets. Radiant energy emitted by the work immediately ahead of the weld controls the process through an amplifier photocell system. J. H. Buckman and L. W. Young, Buffalo, assigned to Linde Air Products Co. No. 393,411.

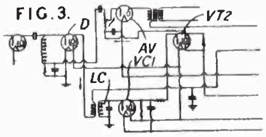
Delay circuits. Time-lag device for keeping a door open for a predetermined time after phototube has been shaded by a passing person, etc. A charged condenser is utilized. Lyons & Co., Ltd. No. 392,928.

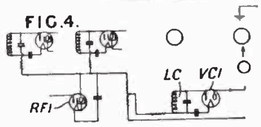
Amplification Detection, Etc.

Filter system. A band-pass type filter structure for inter-stage coupling provided with a certain amount of feedback. Philips. No. 395,111.

Light sensitive cell amplifier. To minimize the effect of temperature, humidity, age, etc., on selenium and like cells, the cell is subjected to a flickering light additional to the controlling light. P. J. Heaton, London. No. 395,422.

Inter-carrier noise suppression circuit. A sharply tuned selective circuit for applying energy of carrier frequency to the rectifier, the output from which controls the demodulated output of the receiver so that the output is suppressed unless the voltage across the selective circuit exceeds a predetermined minimum. M. G. Nicholson, Marconi Co., Nov. 25, 1932. No. 395,569.



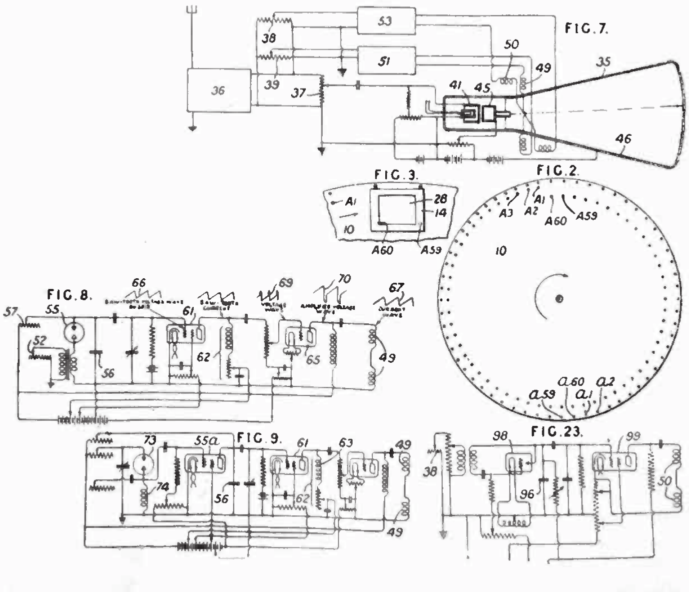


Volume compressor. Circuit connected in shunt to a transmission line, the impedance of which is adapted to be varied inversely as a root of the applied signal current by a control device whose output is proportional to a root of the input, and a corresponding expander for restoring the volume range comprising one or more tubes in series with the line the impedance of which is controlled by a device having a linear input-output characteristic. E.R.P.I., N. C. Norman. No. 396,046.

Modulation system. A radio transmitter is modulated according to an exponential curve. The demodulating characteristic of the receiver is of the same form. The advantage is that the rectified signal strength depends only on depth of modulation so that signal strength is not affected by fading. Telefunken. No. 395,840.

Transmission line. Used in a broadcast redistributing system in which a single aerial is coupled to a transmission line and then to several receivers. Telefunken. No. 396,008.

TELEVISION SYSTEM



Patent granted to A. W. Vause, Marconi Company. Involves cathode ray tube, synchronizing signals developed by a Nipkow disk, etc., etc. No. 395,499

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McGraw-Hill Publishing Company

330 West 42nd Street, New York City

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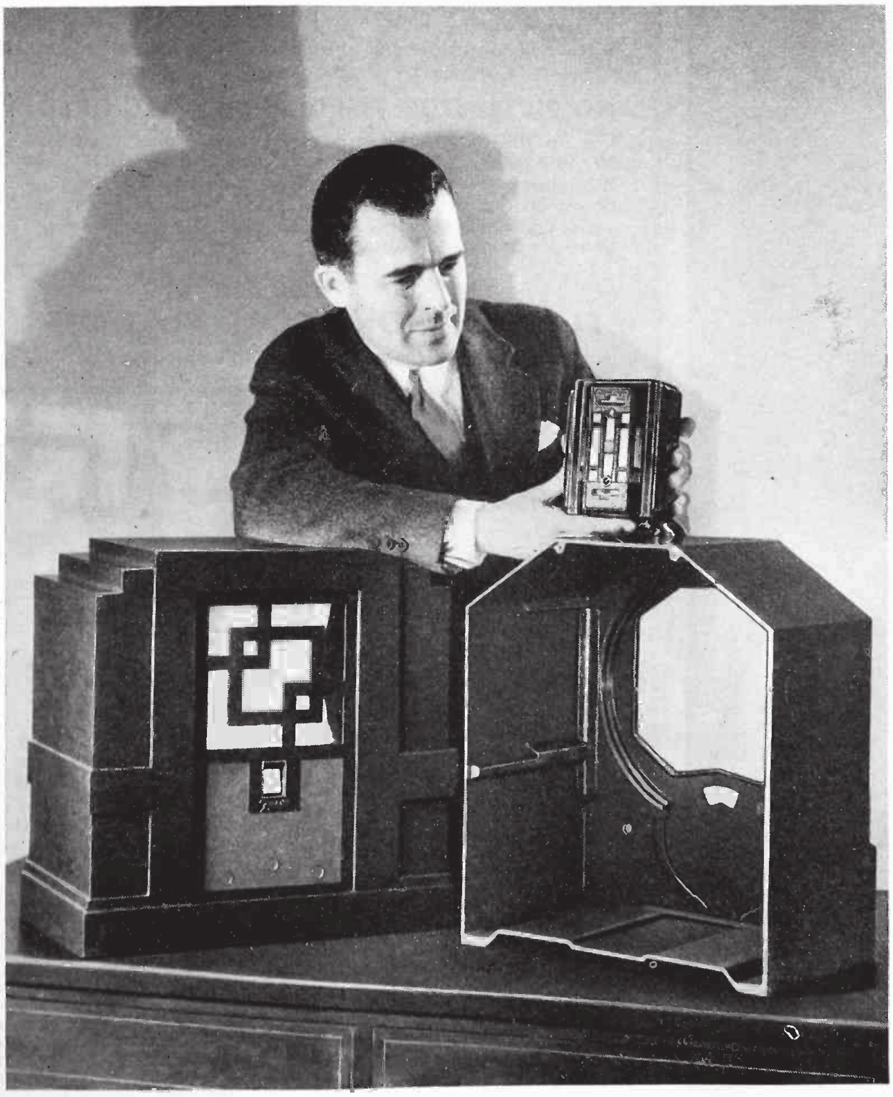

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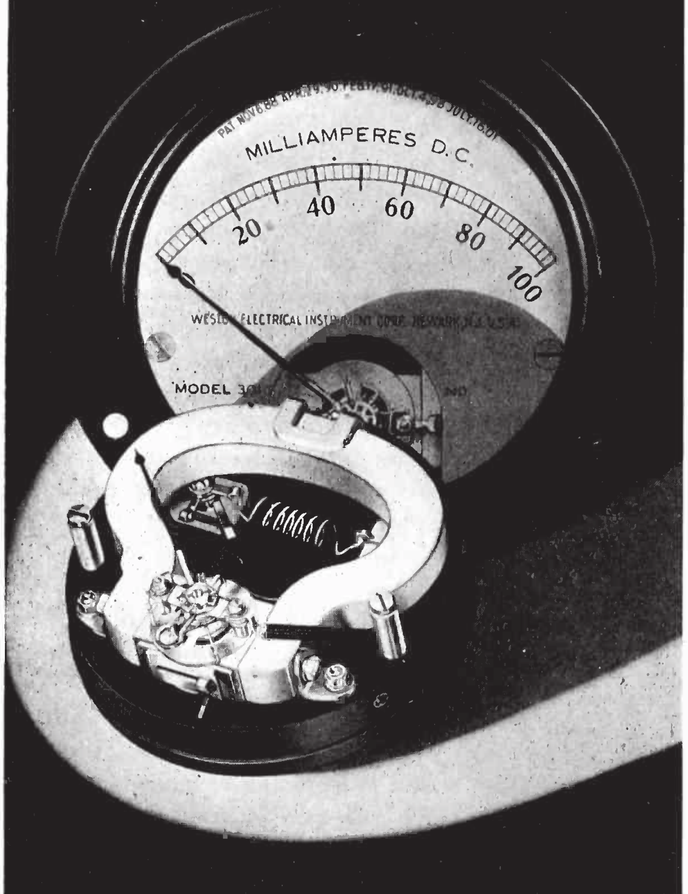

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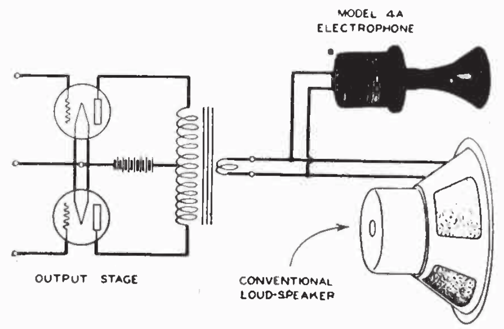

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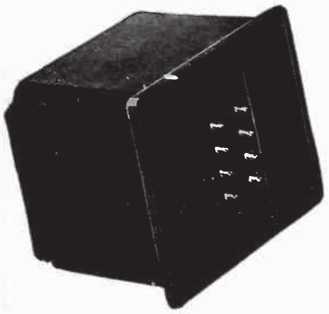

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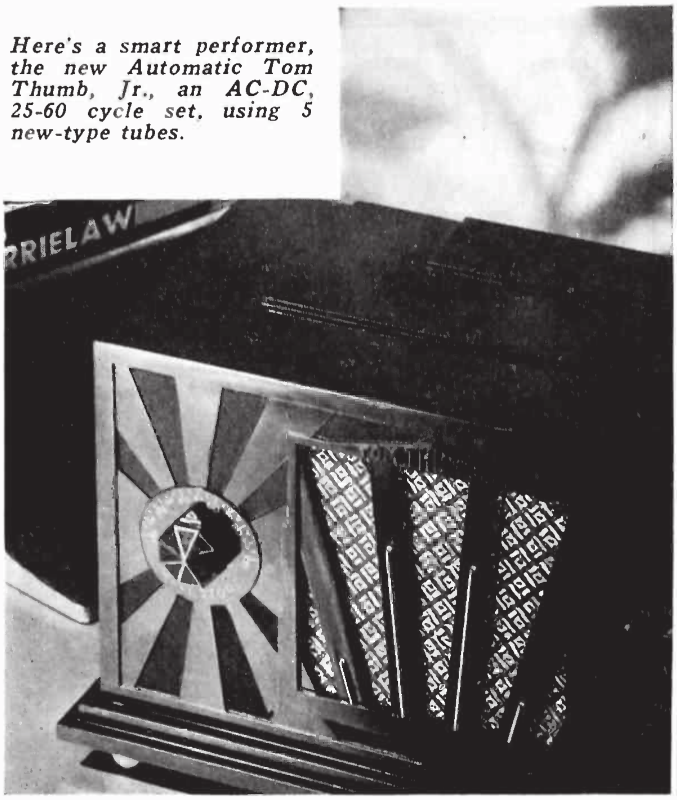

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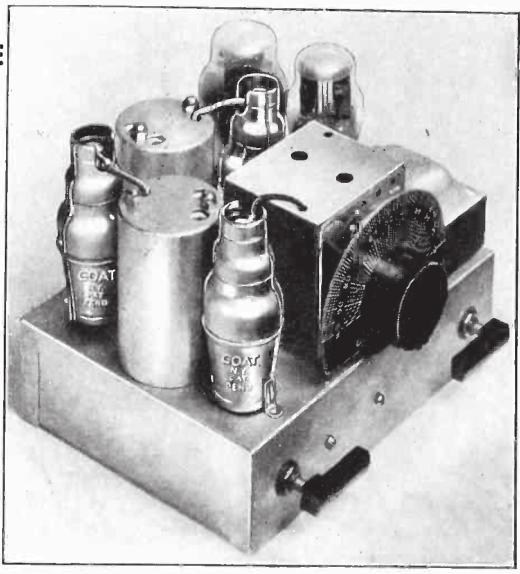

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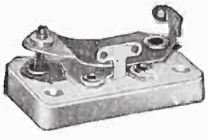

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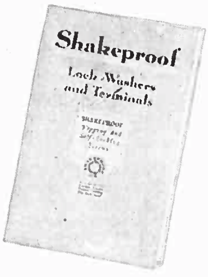

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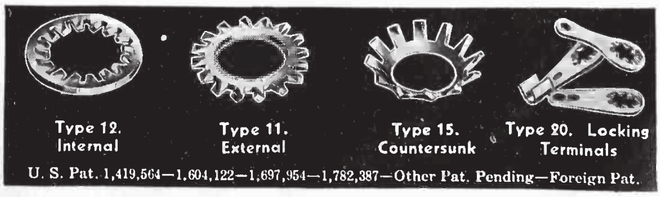

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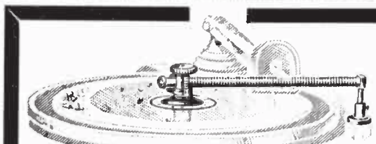

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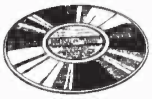

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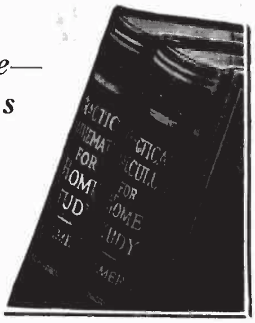

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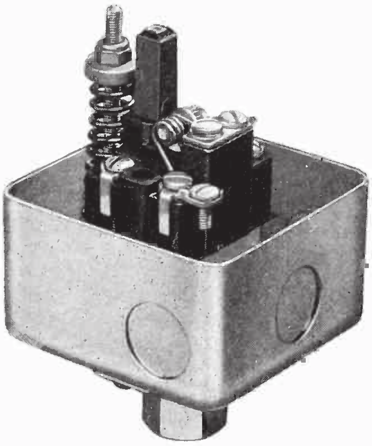

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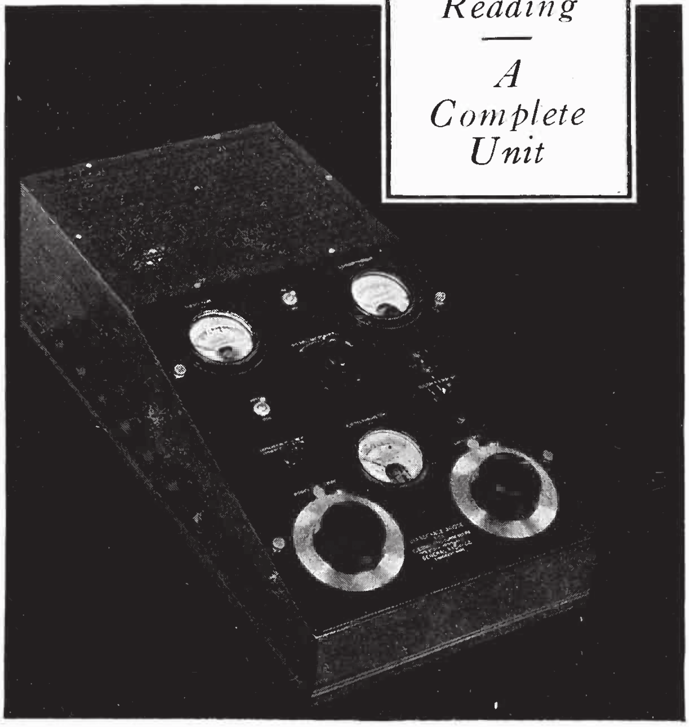

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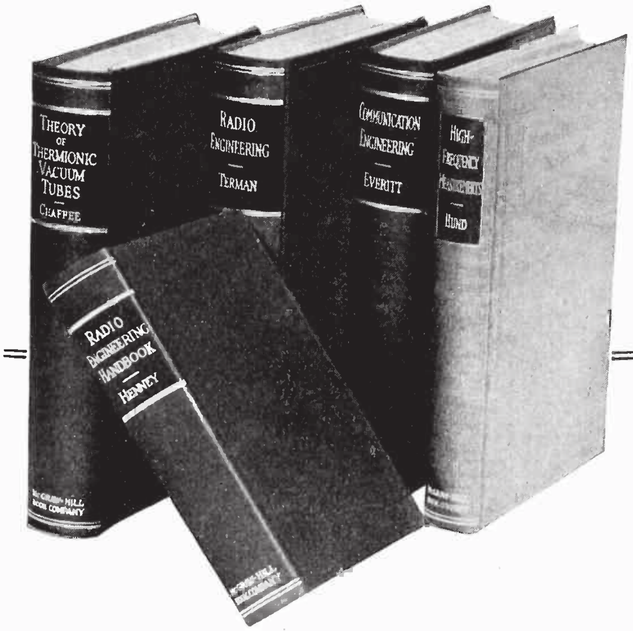
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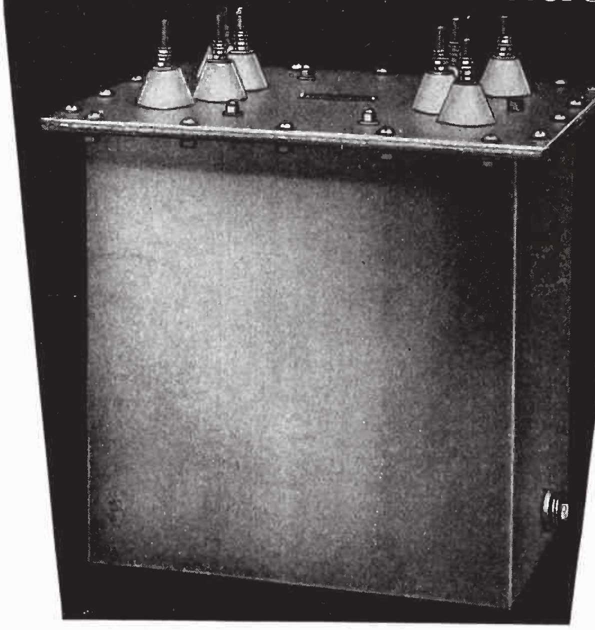

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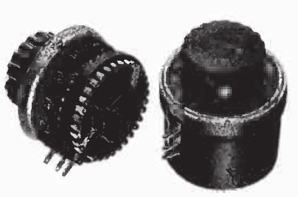

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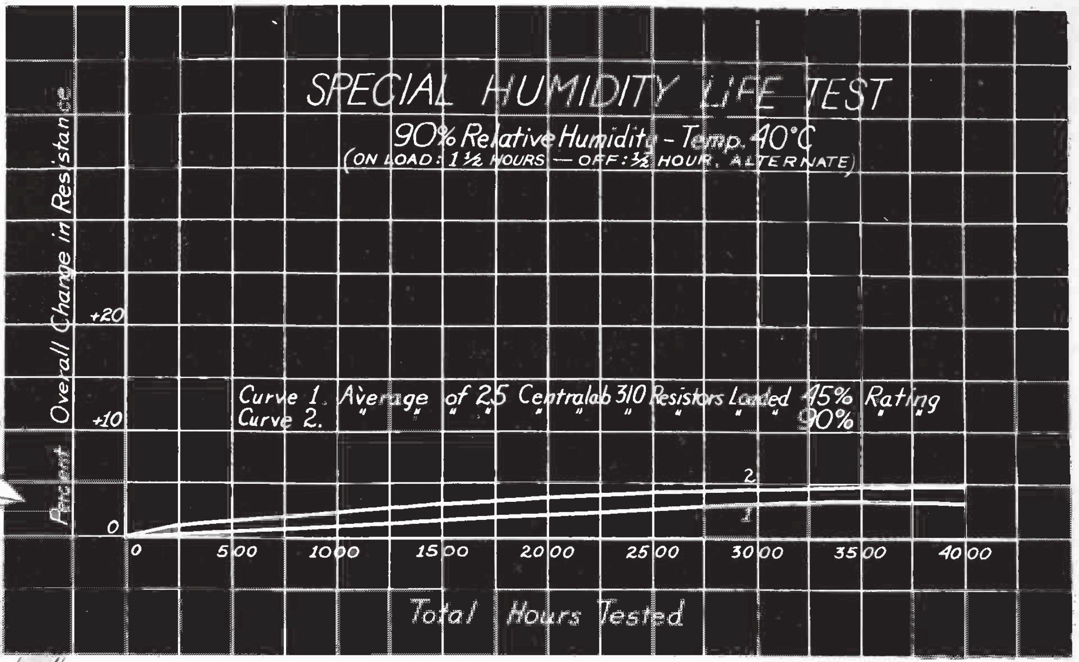

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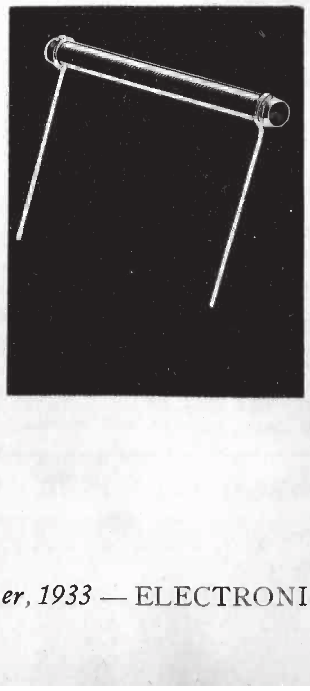

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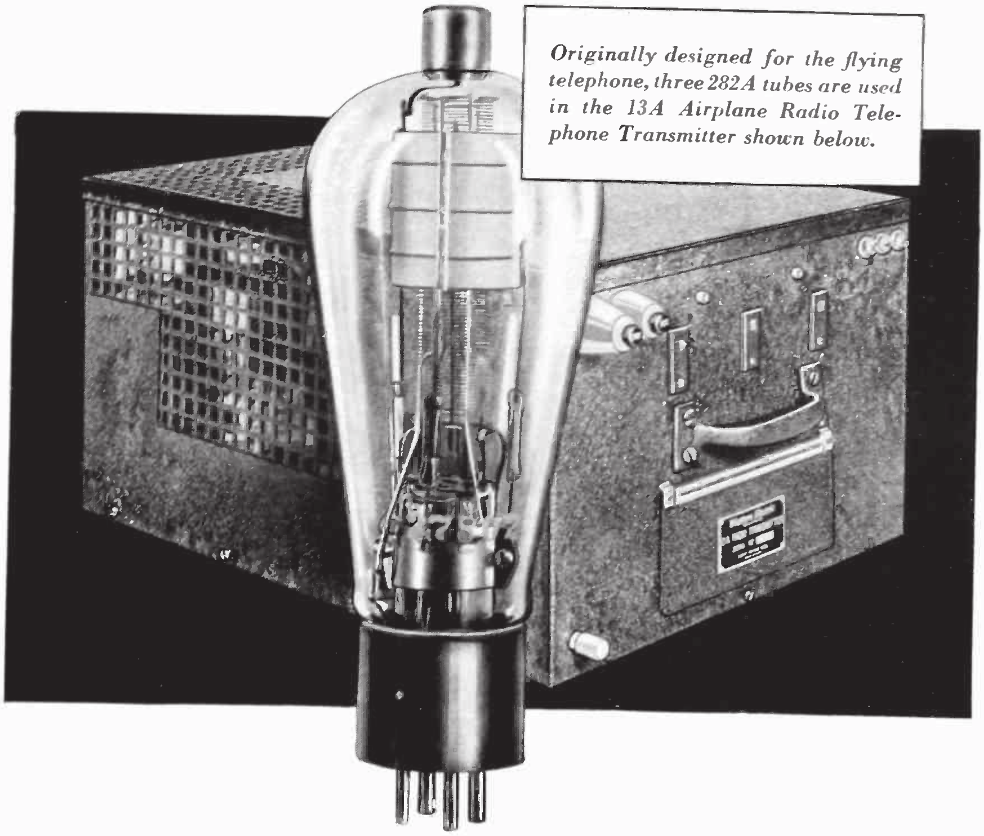
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